THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 52 Thursday, May 16, 1935 No. 978

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1933-34.

Roy Stubbs, 36, Broadway, Cheadle, Cheshire.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, "The Priory," Oughtibridge, near Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: W. Scott, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.
East Midlands: B. Gale, "Oakdene," Greendale Road, Nottingham.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth: J. J. McClelland, 122, Wellington Road, Bilston, Staffs.
Middlesbrough: D. Anderson, 147, Stockton Street, Middlesbrough.
Preston: P. Leyland, 6, Ashley Terrace, Farington, Lancs.
Lincoln: E. R. Walter, "Cavalla," Erntwell Road, Lincoln.
Burnley: W. Haworth, 72, Branch Road, Burnley, Lancs.
Falkirk: H. McNair, 14, Seabegs Crescent, Bonnybridge, Scotland.

National Ironfounding Employers' Association

President: J. Smith, Smith & Company (South Shields), Limited, Nile Street, South Shields.
Secretary: Harold G. Judd, C.B.E., 8, Frederick's Place, E.C.2.

The Institute of Vitreous Enamellers

President: Dr. J. W. Mellor, F.R.S., Stoke Technical College, Stoke-on-Trent.
Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary: Miss E. Christine Elliot, Davis Street, Cubitt Town, E.14.

Foundry Trades' Equipment and Supplies Association

President: R. H. Brackenbury, 13, Victoria Street, London, S.W.1.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary: E. J. Griffiths, 2, Royal Metal Exchange Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. Telegrams: CIRA

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE
A Golden Jubilee	325
The Sheffield Conference.—II	325
West Yorkshire Annual Meeting	324
British Industries Fair, Castle Bromwich	324
The Weathering and Corrosion of Glass by Water, Acids and Alkalis	325
A New Type of Abrasive-Cleaning Machine	328
Function of the Steel Foundry Foreman in Preventing Porosity	329
Copper Curtailment Dangers	332
Iron and Steel Import Duties	332
Patternmaking Economics	333
International Foundry Congress	335
German Foundrymen's Technical Association	336
The Need for Standardisation and Uniform Thought in Welding Subjects	336
This Week's News in Brief	338
Trade Talk	338
Company Reports	338
Contracts Open	338
New Companies	338
Applications for Trade Marks	338
Personal	338
Obituary	338
Glasgow City Exhibition	338
Forthcoming Event	336
Raw Material Markets	340
Sheffield I.B.F. Conference	340

A Golden Jubilee

The recent celebrations remind us that the foundry world has a jubilee of its own which should not be allowed to pass unnoticed. It is fifty years ago since Prof. Thomas Turner, in 1885, presented to the world his first Paper on the effect of silicon in cast iron. There may be still living to-day men with some first-hand knowledge or recollection of how castings were made before that time, but it must have been a very hit-and-miss affair, for while the influence of silicon had been indicated by one or two scientific workers, that year saw the publication of the first systematic investigation. What we owe to this can best be understood by trying to think how metallurgists would get on without it. The task, difficult enough in the ordinary way, would be virtually impossible.

The direct effect of silicon is dependent on other considerations, such as the mass of the casting, the nature of the mould material and its temperature, and the temperature of the molten metal, but it can broadly be said that whatever conditions exist in the mould or the casting, suitable adjustment of the silicon content will enable a machinable casting to be produced. The softening effect of silicon in breaking down the carbide of iron to iron and graphite is usually referred to as its graphitising effect, and this undoubtedly predominates. There is, however, a second effect which is less generally understood. By virtue of breaking down the hard carbide, which would otherwise make a white iron, silicon is a softener. But in solution in the iron as silicide, the silicon hardens the metal, and a point is reached, if the element is increased, at which one effect counterbalances the other. The glazy appearance of pig-irons high in silicon is well known. An iron completely ferritic but containing medium silicon has a higher Brinell hardness than a similar material with low silicon. The ultimate limit is reached in the very high silicon acid-resisting irons containing 12 to 15 per cent. silicon, which are notoriously brittle and difficult to cast, although improvements have been made.

Much remains to be explained and ascertained, but we can look back on great progress during the fifty years. The influence of other elements has been studied, singly and conjointly, and the precise influence of carbon itself is beginning to be understood. It is gratifying to know that Prof. Turner enjoys good health and full activity, and founders will congratulate him on what is for them an important jubilee.

The Sheffield Conference.—II

Last week we dealt in some detail with the Papers to be presented to the Sheffield Conference of the Institute of British Foundrymen, but of major importance also is the question of works visits. There is a choice of eight visits, and these include two large steel foundries (Hadfields and the English Steel Corporation); a large iron foundry making both heavy and light (builders') castings (Newton Chambers); one of the largest steelworks in Britain (Steel, Peech & Tozers); a foundry devoted to the making of centrifugally-cast cylinders, liners and high-duty iron (Sheepbridge Stokes Centrifugal Castings Company); an ultra-modern research department and the cleanest and tidiest steel melting in Britain (Samuel Fox & Company, Limited); a refractory works (General Refractories, Limited), and the new foundry department of Sheffield University. This last visit is of special importance as founders are anxious to know just what equipment has been provided and Prof. Andrew is anxious to have criticisms of his efforts. In any case, real co-operation with the whole of the foundry industry is sought, and we hope that foundry owners and executives will take the opportunity of inspecting the department and finding out first hand its potentialities for training their successors and instituting scholarships for the brightest of their apprentices.

The social side of the Conference includes receptions by the Lord Mayor and Lady Mayoress at the Town Hall and by the Vice-Chancellor and Mrs. A. W. Pickard-Cambridge at the University, and the annual banquet at the Royal Victoria Hotel. The last day is to be spent in Derbyshire, where at the Rising Sun Hotel, Hope, Mr. J. E. Hurst, the incoming President of the Institute, and Mrs. Hurst, are to be the hosts at a garden party. The whole programme is exceptionally well balanced, and there is something of outstanding importance for every member of the Institute. We wish to impress upon those important personages whose sanction has to be obtained before metallurgists, foremen and others can attend such functions as the Sheffield Conference, that a really worth-while opportunity presents itself for acquiring brand-new information which can be relied upon to improve existing methods and reduce manufacturing costs. If the British foundry industry is as progressive as we believe it to be, then the Sheffield Convention should break all records for both attendance and technical interest.

XUM

West Yorkshire Annual Meeting

STEADY PROGRESS REPORTED

The annual general meeting of the West Riding of Yorkshire Branch of the Institute of British Foundrymen took place recently at the Bradford Technical College, under the retiring presidency of Mr. A. W. Walker (Huddersfield).

Mr. S. W. Wise, of Bradford (hon. secretary), in his annual report, remarked that, in reviewing the work of the year, he felt the Branch could justly claim to have made steady progress. The increase in numerical strength was not very noticeable, but it was sufficient for the Branch to have at last reached its first century in membership numbers. Branch expenditure and the amount of subscriptions in arrears compared very favourably with other branches of the Institute. At the opening of the past year the Branch-President (Mr. Walker) had expressed a hope that they might make full use of the latent talent in their own ranks in the contribution of Papers. In his own thoughtful and interesting presidential address Mr. Walker had urged a plea for Papers of a more practical character than had sometimes been the custom. Both these desires had received full endorsement by the Council as a matter of policy, and in practice they had been ably supported by the members generally, the syllabus for the past winter having included very practical Papers by Mr. G. Hall on high-duty cast irons, Mr. S. Carter on complex foundry problems, and Mr. G. Copeman on patternmaking problems, whilst Mr. F. K. Neath had opened the session by leading off a very wide discussion on modern foundry-sand practice, a matter which was further explored later at the lecture given by Mr. Griffiths on the occasion of the Branch visit to the works of the English Electric Company, Limited, at Thornbury, Bradford. The visit to those works had been arranged primarily for Lancashire friends to join the West Yorkshire Branch, but as this could not eventually be conveniently arranged, the Yorkshire members attended in sufficient numbers to make the visit a most successful function. Another highly-interesting visit during the session had been to the works of Messrs. Jn. Fowler, Limited, engineers, of Leeds.

Short Papers

A further effort was made during the session to arrange for a series of short Papers by members who might not feel inclined to go to the extent of a Paper for a full evening's discussion. Particularly was it hoped to stimulate activity among the younger members by this means, and Mr. Walker, the President, had offered a prize for the best short Paper submitted. It was, however, to be regretted that the efforts of the Council in this direction were not successful. It was eminently desirable that the effort be renewed on some future date. The past session had been noteworthy for the fact that the General Council, for the first time in the history of the Branch, held a meeting in the Branch area. This was on the day of the Branch annual dinner in January, and several officers and members of the General Council honoured the Branch with their presence at that function at Bradford. It was a pleasure to be able to mention that Mr. Dyson, of Huddersfield, had presented to the Branch Technical Library volumes of The Foundry Trade Journal for the years 1906-7-8, the contents of which should prove a source of help and interest to the members. It was gratifying to record that one of the Branch members—Mr. David Brown, of Huddersfield—had been appointed a representative of the Institute on the Sheffield University Advisory Committee, and also that, in response to an invitation from the Huddersfield Technical Education Authority, two members of the Branch—Mr. A. S. Worcester and Mr. A. W. Walker—had been appointed to represent the foundrymen on the Huddersfield Technical Advisory Committee. With reference to the contact of the Branch with other bodies, it was opportune to mention that their President, Mr. Walker, had recently accepted an invitation to address the Keighley Association of Engineers on the subject of "Foundry Practice and Problems." In conclusion, the secretary paid tribute to the members of the Branch in general for a generous measure of loyal support and encouragement to the officers during the year.

The New Officers

The following officers were elected for the coming year:—President, Mr. F. K. Neath, B.Sc. (Leeds); Vice-Presidents, Mr. George Hall (Shipley) and Mr. H. Forrest (Bradford); hon. treasurer and hon. secretary, Mr. S. W. Wise (Bradford, re-elected for the eleventh time); Council vacancies, Mr. Paul Durrans (of Penistone), Mr. W. Hawley (Brighouse), and Mr. J. Fearnside (Keighley); librarian and registrar, Mr. H. Bradbury (Huddersfield) and Mr. F. Squires (Bradford). Delegates to the General Council of the Institute: Mr. A. S. Worcester (Huddersfield) and Mr. W. G. Thornton (Bradford), in addition to Messrs. Neath and Wise, *ex-officio*. Representatives on the Institute's Technical Committee: Messrs. Worcester and Neath. Auditors: Mr. G. Hall (Shipley) and Mr. S. Carter (Huddersfield).

Mr. Neath, as a member of the Technical Committee of the Institute during the past year, gave an interesting report on the work of that body, and said he felt it must be agreed that this was one of the most valuable phases of Institute activity that had ever been established, and was a practical contribution in the general effort for the advancement of the foundry industry.

The meeting unanimously accepted an invitation to visit the works of Messrs. Wadkins & Company, wood-working machinery engineers, of Leicester, on May 25. A number of names for the party were taken at the meeting, and it was hoped that other members interested would communicate speedily with Mr. Wise, in order that adequate arrangements could be made for the party's comfortable travel.

A letter was received from the general secretary of the Institute, expressing appreciation of the efforts made by the Branch in keeping down expenses to a minimum consistent with efficient functioning.

Galloway Power Equipment

Messrs. Glenfield & Kennedy, Limited, Kilmarnock, have been given the contract for the equipment of the second part of the Galloway water-power scheme. The contract is one of the largest the firm have secured for some time. The first part of the Galloway scheme was completed a few weeks ago. Work is now going on at the dams and power stations at Loch Doon, Earlstoun and Carlsfad. Messrs. Glenfield & Kennedy will build the equipment for the Ness Glen dam at the outlet to Loch Doon where the level of the water is to be raised by 25 ft. to give extra storage capacity. Three sets of syphon pipes will regulate the level of the loch and discharge abnormal floods. The dam will have two outlets, the lower one controlled by a regulating sluice gate and the upper one will be equipped with a regulating needle valve and jet disperser. Four turbine intake gates will be designed and constructed for Carlsfad and Earlstoun power stations. Each will have a 10-ft. span and be 14 ft. high. An automatic device will close the gates if there should be a break in the pipes leading to the turbines. Two other sluice gates will be built by Glenfield & Kennedy at the Earlstoun dam. All the equipment will be completed by the end of the year and will be in operation shortly after.

Messrs. Glenfield & Kennedy are supplying the greater part of the equipment for new water schemes in South Africa and equipment for gold mines on the Rand. They have also a number of orders for India, including a consignment of 1,375 valves to the Meeryt scheme.

British Industries Fair, Castle Bromwich

The management of the Birmingham and Castle Bromwich Section of the British Industries Fair is this year indulging in the commendable experiment of holding the exhibition in the spring instead of winter. Personally, we hope that the change will be justified, as we never appreciated the inspection of the Castle Bromwich exhibits in an atmosphere of colds, coughs and influenza. Naturally, the change of time has had its effects, and as it clashes with an important meeting of the gas industry, certain well-known firms have refrained from taking space. We hope that this will be but a temporary reaction.

The Fair opens next Monday, and a visit by the Prince of Wales has been promised. During the period of the exhibition, most of the national scientific, technical and trade associations are paying official visits. Amongst these are the Institute of British Foundrymen, the British Cast Iron Research Association, and The Institute of Vitreous Enamellers.

Raw Materials

Several of the great ironworks are to show pig-iron, including the Stanton Ironworks Company, Limited, Staveley Coal & Iron Company, Limited, Stewarts and Lloyds, Limited, Renishaw Iron Company, Limited, and the Workington branch of the United Steel Companies, Limited. Technicians are usually available to discuss those problems of a little higher manganese or slightly lower phosphorus. No sands are shown, but a stand (British Foundry Units, Limited, of Chesterfield) shows Ceylon plumbago.

Foundry Machinery

By far the most interesting exhibit in this section is the Wheelabrator attached to a Tumblast barrel, which is shown by Pneulec, Limited. This is its first public appearance in Great Britain. It has already been described in our columns, but, in common with most, we are looking forward to seeing it in actual operation. Both Electromagnets, Limited, and the Rapid Magnetting Company, Limited, have taken space, so everything of the latest available will be on show.

There are two stands showing patternmaking machinery, and at the other end of the casting process there are quite a number of stands devoted to welding. The one which is of major interest for the repair of castings is that of the British Oxygen Company, Limited, because the oxy-acetylene process is still the most popular method with foundrymen.

Other stands, which command the attention of foundrymen, are those of the Mond Nickel Company, Limited, Imperial Chemical Industries, Limited, and those devoted to stove enamels, such as that of Donald Macpherson & Company, Limited.

The range of castings shown, both as-cast, finished by vitreous and stove enamelling and, of course, built up into machinery, is extremely extensive, and the Fair is probably the greatest exhibition of foundry products one could encounter anywhere. This factor alone always makes a visit to Castle Bromwich worth while for foundry executives.

We deeply regret to announce the death of Mr. Ian F. Panton, director and general manager of Ley's Malleable Castings Company, Limited, of Derby, which occurred last Thursday, when he collapsed and died in the garden at his home at Willington, near Derby. Mr. Panton joined the firm of Ley's as a chartered accountant in September, 1912, and became director in 1917. He took a profound and active interest in the local hospitals and charities, and was a strong supporter of the Institute of British Foundrymen.

The Weathering and Corrosion of Glass by Water, Acids and Alkalis*

By VIOLET DIMBLEBY, M.Sc. (The Department of Glass Technology, The University, Sheffield)

[*Extract.*]

I. The Weathering of Glass

Many samples of very old glasses still retained their transparency, and did not show much sign of visible change due to long exposure to the atmosphere. The surface of glass, however, slowly underwent slight changes even on storage or exposure to the atmosphere, and this process of change was known as "weathering." Such change was not surprising when one considered that natural rocks were gradually being transformed into new substances, as instanced by the formation of clays from felspars, which was reviewed recently by J. W. Mellor.[1]

The slow change taking place on the surface of glass, as in storage, was evidenced by a loss in brilliance, and the appearance of strange patterns on the surface, sometimes developing into an opaque, whitish layer. Under the microscope these deposits on the glass surface were seen to contain numerous crystal forms,

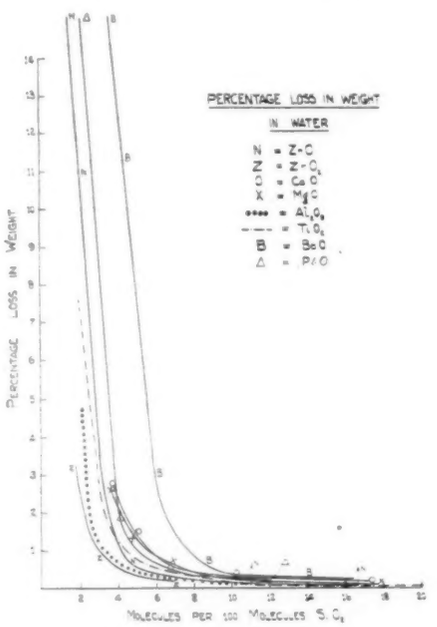


FIG. 1.—PERCENTAGE LOSS IN WEIGHT IN WATER FOR VARYING PROPORTIONS OF SiO_2.

and when tested with indicators, such as phenolphthalein, often gave a strong alkaline reaction.

Some glasses with high alkali content had completely lost their brilliance and transparency when stored in the tropics, where the climatic conditions favoured "weathering."

The chemistry of "weathering" was discussed. Condensation of water vapour on a glass surface brought about hydration, with hydrolysis of the silicates, and borates if present, giving rise to a solution of free alkali. This absorbed carbon dioxide from the air, producing alkali carbonate. The alkaline solution attacked even the silica in the glass, giving rise to new compounds. Also, absorption of oxides of sulphur from the atmosphere resulted in the production of sulphates. Although in the early stages the "weathering" *débris* could be washed from the glass surface with water, in later stages a film of silica remained.

After storage, and removal by washing, of the weathering products from a glass, a more resistant surface was obtained. This subject has been studied in the Department of Glass Technology at Sheffield. The parts played by dust and lichens in aiding the weathering of glass were dealt with briefly, as was also the rhodocosine test devised by F. Mylius[2] for measuring the resistance of glass to weathering.

II. The Corrosion of Glass by Water, Acids and Alkalis

The early Kavalier resistance glass was of the alkali-lime-silica type, but in 1892, following upon his investigations in connection with heat-resisting glasses, O. Schott produced the first Jena laboratory resistance glass. Schott explored the possibilities of zinc oxide, alumina, and boric oxide as constituents of glass, and many of the modern resistance glasses contained these oxides. Development of chemically-resistant ware had progressed rapidly during this century, both here and in other countries. Much scientific investigation had centred round the testing of the chemical durability of optical and chemically-resistant glasses, but space did not allow of an account of this work on complex glasses. While this had yielded valuable information, yet in order to discover the actual influence of the individual constituents of a glass upon its resistance to corrosion, resort had to be made to simple glasses. A short account, therefore, was given of some systematic investigations of the effect of the individual oxides.

Methods Used in Testing the Resistance of Glass to Corrosion

The methods devised for testing the resistance of glass to attack by solutions were grouped into two classes (1) those testing the glass in the form of vessels, etc., as in actual use, and (2) those testing the glass as glass.

Testing Vessels, etc.—The extent of attack was measured (*a*) by the loss in weight per unit area of the glass surface; (*b*) by evaporation of the resulting solution to dryness in platinum and weighing the residue, returning the result as mg. per unit area of surface attacked; (*c*) by titration of the resulting solution against standard acid, reporting all alkalis as soda per unit area; (*d*) complete analysis of the resulting solution; and (*e*) visual examination of the glass after test. Clearly, measurements (*b*), (*c*) and (*d*) could not be made when alkaline solutions were used in the tests, and (*d*) was time-absorbing. Results from method (*d*) had, however, shown that water extracted some of all of the constituents from a glass.

The Standard 5-hr. Boiling Test for 4-oz. Medicine Bottles.[3]—The method of test adopted as a standard by the Society of Glass Technology for 4-oz. flat-panel medicine bottles consisted of filling the well-washed bottles with boiling boiled-out, distilled water, suspending them in steam at 100 deg. C. for 5 hrs. in a specially-designed boiler, and titrating the resulting solution in a specified way to obtain a measure of the total alkali extracted from each bottle. A limit of $5MgNa_2O$ was imposed for satisfactory bottles. The bottles were examined for pitting, etc., after test.

The Narcotine Hydrochloride Test[4] *for Medicine Bottles.*—Another test used for medicine bottles depended upon the precipitation of a 0.01 per cent. solution of narcotine hydrochloride by the alkali extracted from the glass surface. Washed bottles filled with a boiling 0.1 per cent. solution of narcotine hydrochloride were held at 100 deg. C. for an hour in a water bath. Glasses of good resistance did not produce any precipitation within an hour at 100 deg. C.

Keppeler's Cell Method for Sheet Glass.—G. Keppeler and F. Hoffmeister[5] devised a method for testing sheets of window glass, held in a rubber frame so as to form a very narrow cell. The cell was filled with distilled water and suspended in a water bath at 80 deg. C. for 3 hrs., after which the solution from the cell was titrated against N/100 hydrochloric acid using methyl red as indicator, and the result expressed as $MgNa_2O$ per sq. dm. of glass surface.

Extraction Test Adopted by the Deutsche Glastechnische Gesellschaft.[6] — The German Society of Glass Technology employed a test in which the vessel, filled with water, was maintained at 100 deg. C. for 3 hrs., the resulting solution being titrated against N/100 hydrochloric acid, and the alkali reported as $MgNa_2O$ per sq. dm. of surface.

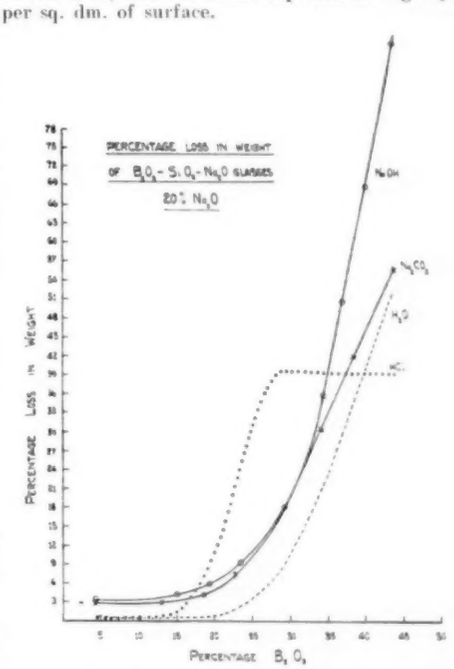


FIG. 2.—PERCENTAGE LOSS IN WEIGHT OF B_2O_3-SiO_2-Na_2O GLASSES, WITH 20 PER CENT. Na_2O AND VARYING PROPORTIONS OF B_2O_3, ON TREATMENT WITH DIFFERENT REAGENTS.

Standard Test for Ampoules.—The test adopted by the British Pharmacopœia[7] for ampoules briefly consisted of a very dilute solution of hydrochloric acid, coloured by methyl red, being placed in the ampoules, which were then heated for ½ hr. in an autoclave at a pressure of 15 lbs. per sq. in. The indicator should not become yellow.

Testing Glass as Glass.—It was shown that the surface condition of a glass exerted a definite influence upon its resistance to attack by solutions, hence, in order to eliminate such effects when investigating the behaviour of glasses as chemical substances, resort was made to the use of glass grains of definite size.

The Sheffield Method.[8]—The method which had been used extensively in the Department at

* A Paper read before The Institute of Vitreous Enamellers, Mr. W. Todd presiding. This Paper refers only to the large class of silicate glasses.

Sheffield may be summarised briefly as follows:—The glass was ground and sieved so as to yield grains passing sieve No. 20 I.M.M. (aperture 0.635 mm.), but lying on sieve No. 30 I.M.M. (aperture 0.421 mm.). After careful inspection the grains were washed free from dust in alcohol, dried, and 10 g., or the weight having the same volume as 10 g. of a glass of specific gravity 2.5, was weighed into a cylindrical 100-mesh gauze container, of platinum for acid tests, stainless steel for water tests, or silver for alkali tests. After a second washing in alcohol and drying, the glass and the container were re-

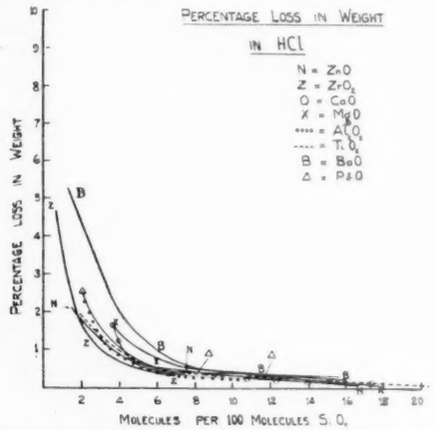


FIG. 3.—PERCENTAGE LOSS IN WEIGHT ON TREATMENT WITH HYDROCHLORIC ACID.

weighed, then suspended in 500 ml. of the boiling attacking solution contained in a beaker, of fused silica for water and acid tests, but of silver for alkali tests. A condensing device was fitted on the beaker top, and boiling was continued gently for an hour, after which the container and glass were removed, washed in water, then alcohol, dried and reweighed. The percentage loss in weight of the glass was recorded, and in the case of water tests the solution was titrated for alkali and, if necessary, boric-oxide content.

The German Method.—The Deutsche Glastechnische Gesellschaft employed a test based on that of J. Enss[9] using 10 g. of grains slightly smaller than those used at Sheffield, the glass being boiled for 5 hrs. in 100 ml. water in a conical resistance flask fitted with a reflux condenser, the flask being suspended in a salt solution boiling at 108 deg. C. The solution was filtered from the glass, evaporated to dryness, and the residue weighed.

The Autoclave Test.—The autoclave test, employing water and steam under pressure, had been applied to vessels and glass grains by a number of workers, including F. W. Hodkin and W. E. S. Turner,[10] but its results could be misleading. The test was useful for glasses which had to stand up to similar conditions in use, *e.g.*, pressure-gauge glasses.

III. The Corrosion of Glass by Water

Influence of Chemical Composition.—Dealing first with fused quartz, the results of F. Mylius and A. Meusser[11] show how, although not attacked by water and acids, this simple material was corroded by alkaline solutions. Results which the author and Prof. W. E. S. Turner[12 13] had obtained at Sheffield when testing glasses built up in a systematic way from simple sodium silicates are summarised later. The method of test[9] already outlined, employing glass grains, has been used throughout.

Two Component Glasses. Soda-Silica Glasses.—From a study of soda-silica glasses, ranging approximately from $Na_2O.4SiO_2$ to $Na_2O.2SiO_2$ it was seen that an increase in the silica content increased the resistance to hydrochloric acid and 2N sodium carbonate solution as well as to water, the attack by 2N sodium hydroxide solution not varying very much over the range tested. Glasses rich in soda were readily soluble in boiling water.

Three Component Glasses of the Type $6SiO_2$ $(2\text{-}x)Na_2O$ x *(RO, R_2O_3, or RO_2).*—Series of glasses based upon the formula quoted, and replacing Na_2O gradually (in many cases in steps of 0.1 molecule) by BaO, CaO, PbO, MgO, ZnO, Al_2O_3, Fe_2O_3, TiO_2, or ZrO_2, had been prepared and tested, the results obtained being depicted in Fig. 1. Replacement of soda by any of the substituted oxides resulted in an increase of resistance to attack by water, the effect being very great for low proportions of the substituted oxide, then falling off to a practically constant value.

Comparing on a molecular basis, the effects of the various oxides, the order of merit over the whole range tested was, proceeding from most beneficial to least ZrO_2, Fe_2O_3, Al_2O_3, TiO_2, ZnO, MgO, PbO, CaO and BaO, this also being approximately the same as the order of the solubilities of the individual oxides in water, as shown by M. A. Besborodow.[14]

C. J. Peddle[15] has investigated the resistance to water of simple soda-lime and soda-lead oxide silica glasses, while G. Keppeler[16] has found that soda-strontia-silica and soda-baryta-silica glasses were not as resistant to water as the corresponding lime glasses. A. Mauri[17] has found that zinc oxide is not beneficial as regards resistance to water at temperatures well above 100 deg. C.

Three Component Glasses in which the Relationship is Governed by Percentage Weight.—

(i) $(80-x)SiO_2$, xB_2O_3, $20Na_2O$.

(ii) $(90-x)SiO_2$, xB_2O_3, $10Na_2O$.

In the series (i) of glasses as represented here, V. Dimbleby and W. E. S. Turner[18] found that substitution of SiO_2 by B_2O_3 had resulted in slight improvement in resistance to water attack so long as the B_2O_3 content did not exceed some 8-10 per cent., but beyond this point the resistance fell off very rapidly, as

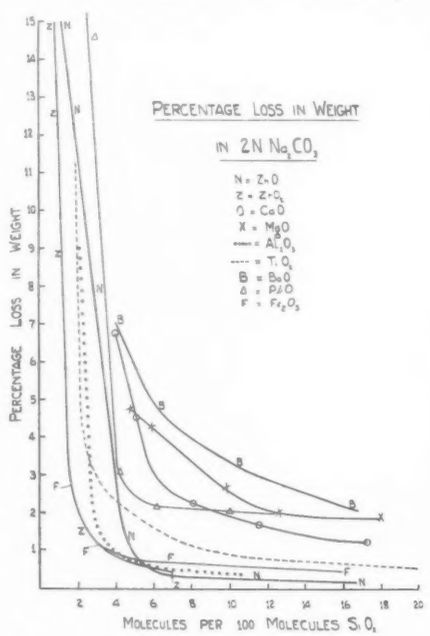


FIG. 4.—PERCENTAGE LOSS IN WEIGHT ON TREATMENT WITH 2N SODIUM CARBONATE.

seen from Fig. 2. In series (ii) no maximum durability was found, the attack gradually increasing as B_2O_3 replaced SiO_2. Water attacked these glasses less than did hydrochloric acid or the alkaline solutions.

(iii) *Replacement of SiO_2 by ZrO_2.*—Replacement of silica by zirconia up to 20 per cent. in a soda-zirconia-silica series showed an increase in water resistance, particularly for low substitutions of zirconia.

Other workers have investigated simple series of glasses, G. Keppeler[19] having shown that alumina improved the water resistance of soda-lime-silica glasses, while J. Enss,[20] replacing SiO_2 by BaO, GaO, MgO, ZnO, PbO, Al_2O_3, or B_2O_3 in series built up from 82 per cent. SiO_2.18Na_2O, found that for a 5 per cent. substitution the order of increasing effectiveness was BaO, PbO, MgO, CaO, Al_2O_3 and B_2O_3. For a 10 per cent. substitution the order was BaO, MgO, B_2O_3, CaO, ZnO and Al_2O_3. Maximum durabilities were obtained in the series of glasses containing MgO, PbO, and B_2O_3, the durability falling off when the substitution exceeds 9, 30 and 7 per cent.

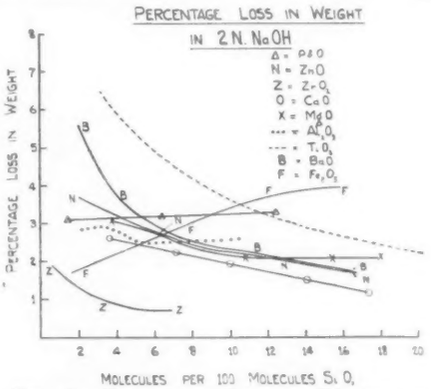


FIG. 5.—PERCENTAGE LOSS IN WEIGHT ON TREATMENT WITH 2N SOLUTION OF CAUSTIC SODA.

respectively. It is interesting to note here the agreement with the work of Dimbleby and Turner in the boric oxide glasses.

W. E. S. Turner and F. Winks[21] have found that replacement of silica by boric oxide in alkali-lime-silica glasses built up from a parent glass closely resembling the Kavalier glass did not result in any improvement of durability towards water, acid or alkalis, but rather was the substitution detrimental beyond some 11 per cent. for water, and 2 per cent. for hydrochloric acid and caustic soda solution.

C. J. Peddle[22] has found that a lead oxide- or lime-alkali-silica glass was more durable towards water when the alkali was composed of soda and potash than when only one alkali was present.

IV. The Corrosion of Glass by Acids

Influence of Chemical Composition.—F. Foerster[23] has shown that the concentration of sulphuric, hydrochloric, nitric, acetic, and oxalic acid had little influence upon the corrosion of simple lime- or lead oxide-containing glasses, and at high concentrations the attack was less than that of water. W. E. S. Turner[24] and co-workers have shown that "constant boiling" strength (20.24 per cent.) hydrochloric acid was more corrosive than strong nitric or sulphuric acid, and this strength of hydrochloric acid was used throughout the researches on the series of glasses already described in Section III. V. Dimbleby and W. E. S. Turner[25] found that substitution of any of the oxides for soda increased the resistance of the glasses to attack by the acid, and generally, oxides which produced greatest resistance to water attack, were also most beneficial for acid resistance, the acidic or feebly basic oxides being again prominent, as seen from the results given graphically in Fig. 3.

The order of merit of the oxides on a molecular basis over the whole range of compositions studied may be given as ZrO_2, Al_2O_3, ZnO, TiO_2, with CaO, PbO, and MgO superior to BaO.

A. Weberbauer,[26] using 10 per cent. hydrochloric acid, in series of three-component glasses similar to those used by J. Enss (see Section

III), found that progressive replacement of silica by various oxides keeping the soda constant increased the durability towards the acid, at first, then decreased it. Maximum values were obtained for the following percentage substitutions:—MgO 7; CaO 9; ZnO 10; BaO 15; PbO 20; B_2O_3 6; Al_2O_3 15, and Fe_2O_3 12.5.

V. Dimbleby and W. E. S. Turner[27] have proved that replacement of silica by boric oxide resulted in improvement in series (i) (see Section III and Fig. 2) only when the substitution was limited to a low range. Beyond 15 per cent. B_2O_3 the attack rose rapidly. The glasses of series (i) and (ii) after test consisted of swollen, hydrated silica. The acid extracted all the Na_2O and B_2O_3 from the glasses, but left the SiO_2 as a swollen skeleton.

V. The Corrosion of Glass by Alkalis

Influence of Chemical Composition.

The action of boiling 2N sodium carbonate solution upon glass was shown to resemble that of water, rather than that of 2N caustic-soda solution, or to lie between the two. In the three-component series (see Section III) used by V. Dimbleby and W. E. S. Turner, the glasses containing those oxides most basic in character (BaO, CaO, MgO and PbO) were generally more strongly attacked by the carbonate than by the caustic alkali over the range investigated, while the zinc-, alumina- and titania-containing glasses were more susceptible to attack by the caustic soda, titania being outstanding in its weakness in this respect. The results are represented graphically in Figs. 4 and 5. The high attack of the alkaline solutions on the high boric oxide-containing glasses was evident from Fig. 2. These glasses, on the whole, remained bright after caustic-alkali attack, the whole of the surface layer being dissolved.

Zirconia was remarkable for its beneficial action in endowing resistance to attack by all reagents, including caustic alkali, but glasses containing high proportions of this oxide were difficult to melt. Lime-containing glasses also behaved well towards caustic soda. This was also found by M. A. Besborodow,[28] who showed that replacement of CaO in glasses by ZnO led to a fall in caustic-alkali resistance. He found that ZnO itself was more soluble in the alkali solution than was CaO. The iron-containing glasses became less resistant to caustic soda as the proportion of iron was increased in the glass, as seen in Fig. 5.

VI. The Influence of Other Factors upon the Resistance of Glass to Corrosion

Among other factors discussed as influencing the attack of glass by water, acids and alkalis were temperature, length of attacking period, state of strain of the glass, the conditions of annealing, and age.

Conclusion

In conclusion, it is desired to emphasise that glasses with high-alkali content were very prone to weathering, even in this country, and readily corroded by the reagents considered. The effectiveness of the other constituent oxides generally differed according to the type of attacking reagent, zirconia alone standing out as an exception. Glasses containing zirconia had shown remarkable resistance to water, hydrochloric acid and alkaline solutions. Glasses containing titania or iron oxide behaved well except towards caustic alkali.

For general purposes and all-round resistance to corrosion, alumina and zinc oxide were noteworthy, while boric oxide was beneficial in quantities not exceeding about 10 per cent. The type of test chosen for measuring the extent of attack upon a glass by any reagent should be chosen according to the aim of the investigation, as surface conditioning definitely influenced the behaviour of vessels or sheets unless the test were prolonged to a stage when such influence was eliminated. The use of glass in powder or grain form eliminated the disturbing influence of surface condition.

The author wishes to thank the Council of the Society of Glass Technology for the permission granted to use the curves representing the extent of corrosion of the different types of glasses.

The lecture was illustrated by 30 lantern slides.

BIBLIOGRAPHY.

1 J. W. Mellor, "Trans. Ceram. Soc.," 1935, **34,** 116.
2 F. Mylius, "Z. Instrumentenkunde," 1888, **8,** 267; and "Silikat Zeit.," 1913, **1,** 3.
3 "J. Soc. Glass Tech.," 1931, **15,** Proc. 52.
4 H. S. Blackmore, V. Dimbleby and W. E. S. Turner, "J. Soc. Glass Tech.," 1923, **7,** 122.
5 G. Keppeler and F. Hoffmeister, "Glastech. Ber.," 1929, **6,** 76.
6 "Glastech. Ber.," 1929, **6,** 639.
7 "Brit. Pharm.," 1932, 633; also "J. Soc. Glass Tech.," 1931, 15, Proc. 68.
8 V. Dimbleby and W. E. S. Turner, "J. Soc. Glass Tech.," 1926, **10,** 307.
9 J. Enss, "Glastech. Ber.," 1927–28, **5,** 449.
10 F. W. Hodkin and W. E. S. Turner, "J. Soc. Glass Tech.," 1922, **6,** 291.
11 F. Mylius and A. Meusser, "Z. anorg. Chem.," 1905, **44,** 22.
12 V. Dimbleby and W. E. S. Turner, "J. Soc. Glass Tech.," 1926, **10,** 305.
13 V. Dimbleby and W. E. S. Turner, "J. Soc. Glass Tech.," 1928, **12,** 52.
14 M. A. Besborodow, "Keram. Rund.," 1927, **35,** 743.
15 C. J. Peddle, "J. Soc. Glass Tech.," 1920, **4,** 71 ff. and 330 ff.
16 G. Keppeler, "Beiträge zur Metallurgie, Goldschmidt-Festschrift," 1921, p. 40.
17 A. Mauri, "Giorn. Chim. Ind. App.," 1925, **7,** 452.
18 V. Dimbleby and W. E. S. Turner, "J. Soc. Glass Tech.," 1926, **10,** 327.
19 G. Keppeler, "Sprechsaal," 1927, p. 239.
20 J. Enss, "Glastech. Ber.," 1927–8, **5,** 449.
21 W. E. S. Turner and F. Winks, "J. Soc. Glass Tech.," 1926, **10,** 113.
22 C. J. Peddle, *loc. cit.*
23 F. Foerster, "Z. anal. Chem.," 1894, **33,** 299.
24 W. E. S. Turner, S. English and J. D. Cauwood, "J. Soc. Glass Tech.," 1917, **1,** 153.
25 V. Dimbleby and W. E. S. Turner, "J. Soc. Glass Tech.," 1926, **10,** 305.
26 A. Weberbauer, "Glastech. Ber.," 1932, **10,** 361.
27 As 18.
28 M. A. Besborodow, "Keram. Rund.," 1927, **35,** 743, and 1928, **36,** 365.

Introduction of Lecturer

Dr. J. W. Mellor, speaking as President of The Institute of Vitreous Enamellers, said he was glad to renew acquaintance with their Birmingham members, and remarked that they would find the lecturer an enthusiastic exponent of the subject before them. He had the opportunity towards the end of last year of going through her published work, and was very much impressed with it from the point of view of its utility, for it provided a real foundation for any future work on the subject. He did not want to anticipate anything she might say, but he might mention that Miss Dimbleby had started building up from the simple frit, as they might put it, and had introduced the different constituents and proportions one by one, and in that way observed the effect of the common solvents on the different products. Now that was exactly what they had to do with vitreous enamels. Before they could get to the bottom of the whole subject they must build it up slowly. If they did not, but proceeded with complicated multiplications, then they were liable to fall into errors. He preferred to deal with two variations only at one time; with three there might develop some confusion. If they started by dealing with the variations of two things, then they could go on by treating them as one unit and making other applications or additions as desired, but they must do it slowly and lay the foundations truly and soundly. This was what Miss Dimbleby had done, and it was exceedingly good work. He would therefore now ask her to put before them "what she thinks is good for us."

DISCUSSION

The Chairman, remarking after the lecture that Miss Dimbleby had given a very lucid and comprehensive exposition of the cause of weathering and the corrosion of glass, said it was a subject which could more profitably be left for discussion to the chemists and those engaged in the development of acid-resisting enamels particularly.

Standard Tests for Stainless Enamels

Mr. J. H. Davidson (Stoke-on-Trent), after congratulating Miss Dimbleby, said the members were more concerned with enamels, but the general principles which had been so thoroughly worked out for glass applied to enamels—the effect of various oxides and the methods of test especially—and they would do well to follow up on similar lines. He would not now ask the lecturer for any concrete methods for enamels, but, as they all knew, the subject of stainless enamels was coming to the fore just now, and they might consider the formulation of some kind of standard test. In America, and most important firms here, they had tests of their own for stainless enamels; but the time had come—and now that the industry possessed a body like the Institute, which was unbiassed, should he say, it was opportune to make a move in this direction—when they might usefully devote some attention to the formulation of a definite standard test for what could be described as stainless enamels. Incidentally, Mr. Davidson remarked that the Germans discriminated between acid-proof and acid-resisting enamels, and said what they particularly needed was an enamel which would resist the action of acids in articles made for ordinary culinary and kitchen use. It should not be impossible to formulate a test, but anything in the nature of a powder test was out of the question, because enamels were not enamels in a powdered state, and there were difficulties in the application of such a test. They wanted to deal with enamel as fused on metal, and to stipulate three main points: the strength of the attacking agent, the temperature at which the tests should be made, and the duration of these tests.

Utility of Powder Tests

Mr. S. Hallsworth (Birmingham) observed that as regards the powder test he could in one respect speak to the contrary. At his company's works they had tried several of the tests mentioned by the lecturer, and he was most interested in her methods. Unfortunately, the difference between a University department and a works was that the former could be supplied with the necessary apparatus and material, however expensive, in order to carry on its work efficiently; but the works generally had to be content with something less, and more often used the slab test. He had tried both the slab and the powder test. In doing the powder test, but without the platinum gauze, they found that the amount of material dissolved by boiling the powdered enamel in a solution of acid was always fairly comparable with the etching test on fused enamel. By taking enamel powder or grained enamel and subjecting it to the acid, they found it nearer than by the etching test, because they obtained a definite factor. True, the methods adopted were crude—they could not use platinum gauze, but invariably they obtained better results in their experimental work on stainless enamels by powder tests than by fusing tests. By taking enamel powder, moreover, they ensured that it was not subject to any variation in conditions in the enamelling shops or muffles. He was particularly interested in the powder test in silica mentioned by Miss Dimbleby, because they had adopted it for enamels and had found it very satisfactory in its results.

Mr. Davidson inquired whether Mr. Hallsworth meant by powder, enamel ground out, or what the grain size was. Mr. Hallsworth replied that they were working on figures of between only 150 and 200, and obtained a fine powder. Mr. A. England remarked that this made it worse, while Mr. Davidson observed that the difference, so one would think, would be larger. Mr. Hallsworth agreed that one might have expected this to be the case, but actually they found the method bore out the test on fused enamel. Unfortunately, there was no definite standard for acid resistance of enamel. Someone brought out the p_H-value test, but it was admitted to be useless for certain alkalis present in enamel. There was only one test that he knew of which was any use, and even that was not

(*Concluded on page* 335.)

A New Type of Abrasive-Cleaning Machine

MOVING PARTS MINIMISED

Mr. John A. Smeeton, M.I.Mech.E., in co-operation with the Phoenix Supply Company, of 35, Snow Hill, E.C.1, of 17, Victoria Street, London, S.W.1, has recently designed and placed upon the market a new type of sand- and shot-blast machine. The plant, consisting of a rubber-lined steel plate chamber of any suitable size, strongly supported by a stout framework, is shown in Fig. 1. The size of the chamber is made to suit the requirements of the work to be done. A partition forming a separate sub-compartment B is built on to the rear wall, and the chamber to enclose the bucket-belt elevator C which lifts the abrasive from the base of the chamber to the discharge hood E.

The floor of the chamber encloses a hand- or mechanically-operated turntable A of suitable size, and carrying capacity as further described herein. This turntable is fitted with renewable segment grids, and the framework of the table is adapted for turning by means of a hand-operated turning gear Z fixed on the outside of the chamber, adjacent to the operating and filling door G. This door slides upon a "Coburn" rail H, which allows it to be opened sideways during charging and discharging of the materials to be cleaned. The door is built in the form of a bay J to allow constant observation through the gauze window L and to give the operator a greater blasting range without trouble. On the door is fitted a rotatable disc M, in which a hole N is provided to allow the operator to insert his blasting nozzle, and thus to cover a maximum blasting area without serious exertion.

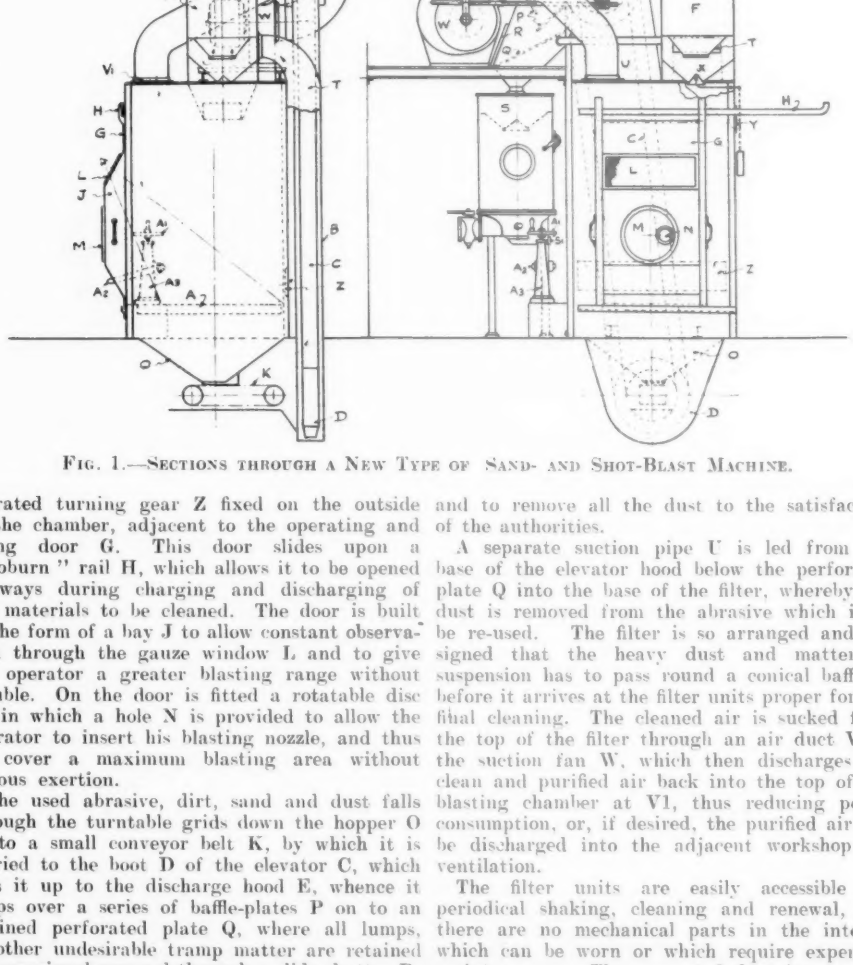


FIG. 1.—SECTIONS THROUGH A NEW TYPE OF SAND- AND SHOT-BLAST MACHINE.

The used abrasive, dirt, sand and dust falls through the turntable grids down the hopper O on to a small conveyor belt K, by which it is carried to the boot D of the elevator C, which lifts it up to the discharge hood E, whence it drops over a series of baffle-plates P on to an inclined perforated plate Q, where all lumps, or other undesirable tramp matter are retained for occasional removal through a slide shutter R. The cleaned abrasive which is to be re-used now falls into the top of the automatic sand apparatus S, through which it passes down to the air- and sand-blast hose and nozzle S1 for re-use. A patented hose and nozzle holder and a high efficiency stream-line nozzle are supplied with the apparatus.

On account of the new Home Office regulations relating to flying or floating dust in workshops, very special care has been taken to design and embody highly efficient dust extraction in this plant. The sand- and dust-laden air is sucked by fan W from the main chamber through a rectangular opening Z situated near the base into sub-compartment B, as shown by arrows. In compartment B, baffle plates or louvres are fixed to precipitate the heavier matter. The elevator buckets and belt also act as additional baffles to prevent the heavier matter passing up to the filter. On the top of the built-in elevator compartment B, of the chamber, is fixed at one end, a rectangular air-suction duct T, which leads into the bottom side of a specially-designed and efficient dry-filter F, with a multiple of oil-surface wetted filter-units contained therein. This filter is of ample capacity to deal with the total amount of dust-laden air and to remove all the dust to the satisfaction of the authorities.

A separate suction pipe U is led from the base of the elevator hood below the perforated plate Q into the base of the filter, whereby the dust is removed from the abrasive which is to be re-used. The filter is so arranged and designed that the heavy dust and matter in suspension has to pass round a conical baffle T before it arrives at the filter units proper for the final cleaning. The cleaned air is sucked from the top of the filter through an air duct V by the suction fan W, which then discharges the clean and purified air back into the top of the blasting chamber at V1, thus reducing power consumption, or, if desired, the purified air can be discharged into the adjacent workshop for ventilation.

The filter units are easily accessible for periodical shaking, cleaning and renewal, and there are no mechanical parts in the interior which can be worn or which require expensive maintenance. The separated dust is removed, when necessary, from the base of the filter F by a slide or valve shutter X through the chute Y, by means of a canvas tube. The shutter X is operated by a weighted lever from the ground. The elevator C is driven from the shaft of the exhaust fan at the top axle by means of a worm-gear drive. The conveyor belt K is driven from the bottom axle of the elevator so that only one driving motor at the fan is required for the whole plant. The rotating of the turntable A, which can be fitted at any desired level in the chamber, is effected by means of a hand wheel A1, which drives a V-belt round the peripheral V groove cast on the rim of the turntable frame. The supply of compressed air and sand from the automatic sand apparatus S is effected by means of a lever A2. Both these controls and the fan motor switch are mounted on the column A3, which is conveniently situated outside the chamber within easy reach of the operator. If considered preferable both the turntable and blasting nozzle can either or both be operated mechanically, and automatically controlled.

The plant is a self-contained unit, and is designed with a view to simplicity. It is arranged to occupy the smallest possible floor space, with every working detail easily accessible. Any reasonable re-arrangement of the individual units can be made to suit the space available. Under the above conditions, one man operating one efficiently-designed nozzle with the most suitable abrasive at the correct air pressure can properly clean with ease and in comfort, more objects, simple and complicated in shape, than is possible with any number of mechanically-operated nozzles, each of which can only impinge upon a pre-arranged path, whereas the man whose manipulation of the nozzles enables him to impinge the abrasive anywhere, can blast any surface for a longer or shorter time, as need calls for it. This he can do if he operates the movement of the table to suit his work.

Recommended Abrasive Pressures

The quality and class of abrasive and the air pressures to be used entirely depend upon the material surface to be cleaned, and as a guide the following is advised:—

For non-ferrous castings and objects of such soft materials a fine quartzose grit at 18 to 20 lbs. air pressure.

For iron castings hard quartzose grit and medium steel grit at 25 to 35 lbs. pressure.

For malleable castings after annealing steel grit at 40 to 45 lbs.

For steel castings last steel grit at 60 to 80 lbs. air pressure.

For steel stampings, steel forgings, steel plates, sections, steel bars to remove scale, steel shot at 45 to 60 lbs. air pressure.

For all cast iron or steel surfaces for enamelling a mixture of fine steel grit and sand at 60 to 80 lbs. air pressure.

In every case special consideration should be given to deal with the objects to be cleaned in regard to design of plant, suitable abrasive and air pressure.

Casting Iron on Metal Moulds without a Chill

According to Dr. J. T. MacKenzie, of the American Cast Iron Pipe Company, of Birmingham, Alabama, the most important metallurgical development in grey iron during 1934 is probably the process perfected by The United States Pipe & Foundry Company "for casting on metal moulds without producing chill." He also includes the further discovery of the prolonged, low-temperature anneal for the strengthening of material so cast. According to patents, this process has been described as blanketing a layer of gas between the metal and the mould, "the gas being held by a powdered material such as ferro-silicon." By this method of casting, says Dr. MacKenzie, they secure a material of about the impact resistance of the old annealed product which is again vastly improved by subsequent annealing which produces a superior phosphide formation in more or less globular form as opposed to the old cellular distribution. A large part of the phosphorus seems to be held in solution.

Function of the Steel Foundry Foreman in Preventing Porosity*

By R. A. BULL,† Chicago, Ill., U.S.A.

[ABSTRACT.]

In order to prevent being misunderstood, the author prefers at the beginning to define what he means by the terms "porosity" as used in this Paper. The word is here employed without attempting to draw a fine distinction between the several small cavities formed by gas, which may exist in steel castings. It is appreciated that there are interesting suggestive differences in the shapes, locations and other observable conditions of those gas cavities that are relatively so small as to be excluded from conventional classification under the term "blowhole." Ordinarily those who make steel castings are accustomed roughly to designate gas cavities of large diameter as blowholes, and gas cavities of small diameter (generally less than ¼ in.) as porosity or pinholes.

Some steel-foundry metallurgists who have intensively studied porosity have narrowed their consideration to each of several distinctive kinds of gas cavities of small diameter, in the understandable desire to distinguish those that come from improper metal conditions, those produced by defective moulds and/or cores, and some that can advantageously be more narrowly identified. The author is in full accord with the purpose behind these differentiating efforts when it is obvious that they are made with the intention of relating causes and effects. Occasionally some analytical studies of this character, while having much potential value, are confusing to the practically-trained superintendent and foreman for whom these notes on porosity are specially written.

From what has been explained it will be clear that for the purpose of the present discussion porosity is regarded as any form of gas cavity of small diameter, whether the cavity is wholly or partially spherical or elongated, and whether the defect lies in the central portion of a member or at such a shallow depth as to be apparent after the casting is shaken out, or is uncovered when annealing scale is removed. Steelfoundrymen know that, when porosity exists, frequently (but not always restrictively) it seems inclined to manifest itself in cavities that are very close to the skin of the metal. In these cases often the holes are elongated, having at some point diameters comparable to that of the ordinary pin. As is well known, some of these cavities, at the surface that is exposed on the removal of annealing scale, are only large enough to permit the careful insertion of a pin; hence, the customary term "pinhole."

Porosity Related to Types of Castings

It is generally recognised in the steel-casting industry that pinholes constitute one of the chief defects occasionally experienced by most foundries that specialise in the production of small, high-grade steel castings. While the porosity evil is not confined to small pieces, its commercial significance in the lighter products of the steel foundry is greater than in the heavier castings, for several reasons.

In the first place, the standard of acceptable appearance is higher for small castings than for large ones. To a considerable extent (although there are numerous exceptions to the rule), the approach to perfection in appearance desired by the average consumer becomes greater as the casting becomes smaller. This discriminatory factor is soundly based on economic principles, so far as these apply to the current viewpoints of industrialists. The average observer is not apt to notice and be critical about a few pinholes in a base plate, but he would regard them as undesirable in an exposed motor-lorry bracket.

Another reason for the greater commercial significance of pinholes in light castings lies in the fact that, in many instances, the influence of a gas cavity is potentially more serious in respect to serviceability of the small part than in the case of the large casting. Of course, this is due to cross-sectional dimensions and the established factors of safety. A great many large steel castings are purposely made heavy, for the advantage that is derived partially from mass, supplementing dependence on the inherent stress resistance of the material. (Parenthetically it may be admitted, however, that in the past, probably a large amount of metal in castings was wasted in supplying weight unnecessarily. It seems worth while here to interject the comment that for numerous applications mass is very desirable, within reasonable limits; and that careful judgment should be exercised in reducing the weights of industrial parts to the apparent permissible minimum. Some present tendencies in weight reduction may be carrying a useful policy too far.)

It would be superfluous for the present purpose to elaborate on the difficulties caused for the foundryman by porosity. But it may not be out of place to mention the fact that, whereas gas cavities of every kind are much less frequently found now than they were formerly in castings of comparable kinds, the average consumer's attitude has increasingly become more exacting as to those details that affect surface appearance and more critical as to all factors that influence stress resistance. It would seem that the changes in preventive measures in the foundry and in the viewpoint of the customer substantially balance each other, with the result that porosity to-day is as serious a problem as it was 20 years ago, considered in respect to the current standard of acceptability adopted by the average buyer.

The author's comments on the causes and prevention of porosity in steel castings are prompted primarily by the hope that emphasis placed on certain manufacturing principles that are more or less generally known may be helpful to foremen who are expected to make steel castings free from pinholes. The Paper is written mainly from the practical standpoint of regular production, not from the theoretical standpoint of scientific metallurgy. This comment might be misleading if the author did not now choose to testify gratefully to the considerable assistance received by practical men from competent technologists who have studied the perplexing metallurgical conditions related to the subject. The author is attempting to supplement other contributions on the same topic by outlining in their apparently proper perspectives, some factors which can be readily understood by men on the foundry floor, and which may be major or minor causes for small gas cavities. If much of the present effort seems to some persons to be needlessly elementary, it might be suggested in justification for stating certain well-known facts that the latter are so important as to merit repeated references. It is hoped that benefit may thus accrue to busy superintendents and foremen who frequently have their attention concentrated on production problems to the extent of causing occasional oversight of certain fundamentals.

Ladle Contamination

Everyone who is familiar with the circumstances knows that pinholes in steel castings are caused by gas which may come from each of several sources. We know that steel made as nearly perfect as is now commercially possible contains some gaseous and other impurities when it is discharged from the furnace. Experience demonstrates that well-made steel as tapped does not contain enough gas to cause complaint regarding porosity, when all conditions of metal transfer from furnace to mould and when all conditions within the mould itself are as nearly perfect as they can be commercially maintained while making certain kinds of castings. It is realised that gas of an amount and/or kind that may cause porosity in a satisfactory mould may exist in steel as it emerges from the furnace spout, if the metal is not properly conditioned before tapping. The fact that gas always is generated in every kind of sand mould, whether or not poured under ideal conditions of metal and mould, is patent to everyone who occasionally witnesses foundry operations.

Those who make steel castings require no evidence to demonstrate the fact that commercial steel that is satisfactorily (while not entirely) degasified before it is discharged from the furnace may absorb some gas that will be subsequently manifested by porosity, in one or more ways by which the metal may be contaminated in its transfer from furnace to mould, or in its function of filling the mould. It is a favourite indoor sport for some foundrymen to argue pro and con as to whether most of the porosity in steel castings is caused by defective metal or by improper mould conditions. It is doubtful whether many such general discussions are very helpful, since they seem apt to make the furnacemen and the moulding foreman blame each other dogmatically during occasional porosity epidemics to which some steel foundries unfortunately are subject. The author believes, however, that the very nature of all the operations required for the manufacture of a steel casting are essentially such as to introduce a greater number of potential hazards in respect to moulds than in respect to metal. There appear to be more details of the personal element involved in making most moulds than in melting steel, with a correspondingly greater opportunity for shop practices to go wrong with the receptacle that will receive the metal to form a casting.

Effect of Gas on Liquid Metal

Turning attention to the first detail that concerns the foundry foreman, namely, the delivery of the metal from the furnace, it seems worth while to comment on the fact that the mere contact of the liquid steel with the atmosphere and with any material that may form gas may develop a condition in the metal ultimately manifested by porosity. The liquid metal generally seems to be highly susceptible to contamination through contact with gas and many other substances. Because the shop atmosphere presents the opportunity of an oxygen pick-up by the steel, metal that has minimum contact with the atmosphere from the time it is tapped until it is poured into a mould obviously has the least opportunity to become contaminated in its necessary transfer. Of course, this means that a bottom-pour ladle offers the least opportunity during transfer for deterioration by means of oxygen (which we know to be one fruitful source of porosity). Logically, then, the emptying of the furnace into a large bull-ladle, followed by transfer of the bull-ladle metal to the moulds by means of shank pots carried a considerabe distance mechanically or manually, provides the maximum opportunity, when transporting the metal, for it to absorb oxygen and thus acquire a greater tendency to throw the final balance on the wrong side, and cause porosity in the steel casting. This matter of balance will be referred to later.

The chief purpose of these comments regarding metal transfer is to emphasise the fact that the liquid steel always is in a receptive condition to the influence of every element which may

D

* A Paper read at the Annual Meeting of the American Foundrymen's Association.

† Consultant on Steel Castings.

XUM

be present as a constituent of the shop atmosphere, and of the linings for furnace spouts and for pouring ladles, even prior to entry of the metal into the pouring cup of the mould. At no time following the tapping of the heat does there exist an entire absence of conditions which may cause porosity, and which frequently result in that defect if careful precautions are not taken by the men on the foundry floor. Obviously, this important fact should be kept in mind constantly by every member of the staff responsible for pouring, moulding, or core-making details.

Influence of Aluminium

Before discussing specifically those conditions obtaining within the moulds which may cause porosity, a few comments on what many persons call final "deoxidation" seem to be in order, although it is the assigned function of another author to cover the subject of melting and conditioning the steel in such manner as to prevent porosity.

Much work has been done intelligently but unsuccessfully to find a substitute for aluminium which would have that element's marked affinity for gas, but would not injuriously influence the ductility of steel in the manner frequently demonstrated when aluminium is introduced and tension test-bars subsequently are pulled. It is pertinent to remark that since it is *gas* and not merely oxygen which we want to eliminate, and since there are several gases present in the steel, the term "degasification" rather than "deoxidation" is the more appropriate one to use in connection with the final efforts to condition the steel for the prevention of porosity (and blowholes) in castings.

Some foundrymen pin their faith to special degasifying practices in the belief that these represent a technique which is superior to that involving the customary addition of aluminium. And there are persons who have held that essentially the incidental rather than the primarily-sought effects of gas elimination by means of aluminium are different from the results obtained when another active degasifier is used. Some experiments made during the last few years have thrown considerable light on this entire question. Evidence has been presented by Sims and Lilliequist,* rather strongly indicating that we need not necessarily be handicapped by significant loss in ductility through the use of aluminium, but that we may introduce compounds that serve to make the impure products caused by aluminium addition to be much less injurious than they usually are, as ascertained by certain physical tests. Careful work that has been done suggestively points the way to feasible practices that may be dependent on ordinarily for making inclusions behave themselves decently, when they are caused by adding aluminium to steel.

We know that when any element or compound eliminates any gas from steel, the constituents of the gas are not actually destroyed. They have merely become transformed into what will become solids, in some kind of association with other elements. These resulting non-gaseous impurities become disseminated through the metal in the form of inclusions that usually are so small as to be observable only under the microscope. It seems unreasonable to the author to imagine that any degasifying element may be found which would not put into the steel substantially as large an amount of impurities in the form of inclusions as is created when aluminium is introduced—provided that the material substituted for aluminium would be equally effective in eliminating the gas.

If the facts are as suggested, several important matters must be kept in mind. Obviously, it becomes highly desirable to try to develop a practice that may make harmless the inclusions created by degasification. The work done by the investigators previously mentioned indicates that iron oxide is very useful for the purpose referred to, by causing the inclusions developed by the introduction of aluminium to assume rounded rather than elongated shapes. Considerable evidence has been presented tending to show that it is the angular and elongated rather than the spherical inclusions found in aluminium-treated steel which are harmful to ductility, as indicated by the tension test. Seemingly, long inclusions have a tendency to form continuities, in chains somewhat roughly resembling irregular streaks of foreign matter. When the inclusions are more nearly spherical, they appear to maintain a sort of individual independence, having no significant inclination to closely approach each other.

Cleanliness Standards for Steel

It would be premature now to conclude definitely that inclusions may be caused in aluminium-treated steel, through the introduction of oxide or by other means, to assume forms with the result that the metal is not injured. Future tests of regular or special nature might show some injurious influence of inclusions resulting from degasification, however the inclusions may be shaped and associated. But until more information is obtained on this entire subject, it seems clear that the development of cleanliness standards for steel, as indicated by the number and/or total volume of inclusions per unit of measurement, should be approached very cautiously by those who make or use steel castings. Parenthetically, it may be stated here that the subject now has practical rather than merely academic significance, because of the existence of some private specifications which prescribe standards of acceptability according to the microscopically-observed amount of inclusions in specimens taken from steel castings.

Many foundrymen know that liquid steel, which always is potentially subject to contamination causing porosity (on account of the many chances for contact with gas and gas-forming materials) may be poured in certain portions of moulds where design conditions are not conducive to the development of pinholes, while other members of the same castings or other castings poured from the same heat may be so designed as to be extremely susceptible to this troublesome defect. Experienced steel foundrymen know that with a given condition of metal and kind of green sand used for the mould, certain castings are not apt to show porosity, while other castings are so shaped as probably to develop pinholes, unless extra precautions against the formation of porosity are taken.

Now a test specimen might be chosen from a casting member of such nature as to exhibit no porosity, while showing a condition of cleanliness as observed under the microscope, satisfying the requirements of some highly-technical specification. But at the same time, many castings covered by the purchaser's order might be so designed as to require extreme precautions in preliminary and final degasification for preventing porosity. The observed standard of cleanliness in one microscopic specimen might actually indicate, because of a small amount of inclusions in it, an inferior condition of the metal considered from the standpoint of its susceptibility to such small gas cavities as are favoured by design factors. In other words, the inclusion index for satisfactory steel castings may, dependent on the nature of the castings furnished, in reality be an indication of inferior final treatment of the steel intended for some specific foundry application, although the metal might be highly satisfactory for other purposes. Final degasification can be performed in such manner as to represent effective inoculation against porosity, in the face of serious hazards to solidity.

Opposing Views on Steel Inclusions

It is hoped that this digression on inclusions may seem to have its proper place in this discussion. Because there are, and probably always will be, held by some opposing views regarding such matters as inclusions in steel, frequently it is difficult to decide on the correctness of any opinion. Sometimes all persons concerned are partially right and partially wrong. In any case, it ought to be clear to steel foundrymen making high-quality material that dependence alone on any final, very effective degasifier may be a very unsafe practice. Of course, this means that every feasible expedient should be employed for restricting to the smallest extent the formation of gas that may be taken up by the metal, and for providing adequate outlet for the gas that is produced.

Possibly some consumers would say that one obvious solution of this problem is to use among other expedients no mould materials that contain gas-forming constituents that can be discarded; and that therefore green sand should be prohibited for the manufacture of steel castings desired to be practically or entirely free from porosity. Undoubtedly many classes of steel castings should be poured in thoroughly-dried moulds. But the experienced steelfoundryman required to make products of infinitely-varied shapes, including many having designs of particularly susceptible nature in respect to shrinkage cracks, realises that the substitution of baked sand for green sand for some steel castings ordinarily or occasionally would result in contraction defects more serious than those usually caused by pinholes. In any case, the present-day steelfounder, being required to consider carefully his production costs, must keep in mind constantly such willingness to pay as the customer may manifest. Every detail of manufacturing cost must be considered, including the item of dry-sand moulding, which, of course, usually is considerably greater than that of green-sand moulding.

However we may view this entire question, it is perfectly obvious to the steelfoundryman who serves customers expecting freedom from porosity in their castings that there is commercial justification for establishing and maintaining many practices to restrict the formation of gas in the mould, following the conditioning and transfer of the metal in such ways as to bring it to the moulds in the minimum state of gas contamination. It is the purpose of the author to itemise some procedures that are believed to be practical for attaining this objective. No originality for developing these practices is claimed in submitting the result of an effort to summarise precautions feasible to take on the foundry floor.

CONDITIONS WHICH MAY CAUSE POROSITY

Volatile Matter in Furnace Spout

This condition may be caused by the use of molasses or other liquid binders in the spout lining, or by insufficient drying of the spout lining.

It is the safest plan to make up the spout lining without any gas-forming ingredient that can be feasibly eliminated. It is very advisable to dry the spout lining thoroughly, and to avoid any last-minute smoothing or patching with moist material, where part of the spout lining may have spalled or cracked while being dried.

Insufficient Dryness of Ladles

This may be due to a generally poor shop system or to occasional carelessness. Every part of a ladle which comes into contact with the liquid steel should be made red hot if possible before the metal touches it. The practice of daubing a ladle lip with green moulding sand or a clayey mixture is badly overdone in some foundries, and should always be avoided if possible. Moisture in plastic material is changed to steam when the steel flows over it, and some of this gas is very apt to be absorbed by the metal.

This objectionable effect can be produced by using for ladle linings certain dry materials that form considerable gas when in contact with the

* Sims, C. E., and Lilliequist, G., "Inclusions—Their Effect, Solubility and Control in Cast Steel," "Transactions, Iron and Steel Div., A.I.M.E.," Vol. 100 (1932), page 154.

hot metal. Substances that are capable of forming gas under these conditions include all the farinaceous binders, which are not well adapted for ladle-lining mixtures.

Lack of Steam Vents in Ladles

Vent holes in ladles may be insufficient in number or be plugged with refuse material that should have been removed. Steam is generally created in a ladle lining when the vessel is filled with liquid steel and holds it for a considerable period of time. If the steam cannot escape through the lining and pass out through vent holes, it may be absorbed into the steel and cause porosity.

Old Sculls in Ladles Receiving Fresh Metal

Frozen metal in the form of a ladle scull has an oxide formed on its surface as the result of contact with the atmosphere. This iron oxide may generate gas when molten steel is poured on top of the scull. If gas is developed in this way, it is apt to be taken up by the liquid steel.

Inadequate Final Degasification in the Ladle

This may be due to disregard of instructions as to adding proper amounts of aluminium or other degasifiers. Such material is most effective in taking up the gas present in ladle metal when the degasifier is put into the ladle immediately before it receives the steel, or when special methods are employed for plunging the degasifier into the filled ladle in such manner as to secure good distribution. (Regulated additions of any material to a teapot ladle are extremely difficult to make effectively.)

Exposure of Tapped Metal to the Atmosphere

After the steel is removed from the furnace, contact with the atmosphere permits the absorption of oxygen by the steel from the atmosphere. This can result in appreciable degree from a very long carry of shank-pot metal. Obviously, a bottom-pour ladle emptying steel directly into moulds results in minimum atmospheric contamination of the steel. The oftener the metal is transferred with its surface exposed to the air, the more opportunity there is for oxygen to combine with some elements in the steel and form oxides that may injure the metal by causing porosity and/or other defects.

Ladle Additions of Alloys

Whenever "carbon powder," ferro-chromium, or other similar material is placed in a ladle for changing the chemical composition of the contained steel, gas is produced. If any such material is added to the large ladle at the furnace spout, the gaseous condition of the steel that goes into a mould is not apt to be so pronounced as when the same proportions and kinds of alloying materials are put into shank pots (which may be used in conjunction with bull ladles), just before moulds are poured. The time element is important in permitting the developed impurities to rise toward the surface of the metal. These compounds are partially or wholly non-metallic and are lighter in weight than equivalent volumes of relatively pure steel. Extra precautions need to be taken to prevent pinholes in castings when making ladle additions for alloying purposes, especially in the use of hand ladles.

Dipping Tools in Pot Metal

Often a skimming rod which has been used for some time is dipped into a shank pot of steel, and when made red hot at the end is pointed at the gate cup to help the steel pourers clearly to see the opening for the metal stream. Occasionally, these skimming tools have adhering to them considerable oxidation scale and foundry-floor refuse. Such a condition may result in the formation of gas taken up by the metal, causing pinholes. Considering the various kinds of gas-forming materials that may temporarily or permanently be attached to a skimming rod and be volatile at the temperature of liquid steel, the safest plan is to use only such skimming tools as are relatively clean.

Inadequate Feeding

Some persons think this is a contributing cause for porosity, but probably the relationship is non-existent, and is assumed after inaccurate diagnosis. Where the design of the casting and the nature and position of the risers are such as to prevent complete feeding at fillets and corners, occasionally there is found what seems to be a concentration of pinholes. In this way pinholes may *appear* to be caused by inadequate provision for shrinkage.

Excess Moisture in Facing or Backing Sand

Very thorough sand mixing is necessary to prevent too much moisture in part of the batch, and not enough in another part. Skilful introduction of binders helps to distribute the moisture. When very much dry binder is dropped into a mixer batch at one time and immediately comes into contact with much moisture, the binder may become soaked and retain the water; possibly later forming a strongly-bonded, lumpy mass of material that cannot be distributed properly through the sand, and may be much wetter than it should be.

The extent to which moisture is needed in the mixture as delivered from the sand mill, is largely regulated by precautions taken against the evaporation of moisture in the transfer of the sand to the moulders, and in the storage of the sand at moulding floors and benches. Weather conditions have considerable effect on the rapidity of moisture evaporation. During rainy days evaporation is greatly retarded.

The use of pure bentonite or a bentonite product calls for a smaller amount of water in the sand mixture than when fireclay as the sole or chief dry binder is employed. When water in the mixture as dumped from the mill does not get opportunity to evaporate to any extent, it may be best, from the standpoint alone of porosity prevention, to use a bentonite material instead of fireclay as the principal binder. But other conditions, such as evaporation, should be kept in mind. If so much water evaporates as to leave the sand crumbly, of course trouble results in dirt spots and other defects. Probably the use of any cereal binder helps to prevent moisture evaporation, but care should be exercised in using such material because of conditions to be mentioned later.

Excess Dry Volatile Matter

It has been indicated that precautions should be taken when using cereal or farinaceous binders. They burn quickly when exposed to the liquid steel. One result of such combustion is the formation of gas. If ample opportunity is not afforded for such gas to escape, pinholes are apt to result. Quantity of binders and volatile materials should be carefully regulated, and they should be thoroughly distributed to prevent a surplus of such ingredients in a portion of a batch of facing. If considerable, poorly-distributed, volatile material is rammed against a pattern, that part of the mould will form a large volume of gas as soon as contact with the metal is made.

Low Permeability

One cannot state in accurate, general terms how low a permeability value in facing or backing sand causes likelihood of porosity. Not only does the sand mixture itself influence susceptibility, but the thickness of the mass of sand above the mould cavity has much to do with the matter. A cope having a shallow layer of sand (facing and backing combined) naturally permits gases to escape between the particles of sand more quickly than a cope having a thick layer of the same kind of sand. It is the safest plan to learn from experience with a given sand the permeability that is necessary for the deepest moulds; also for moulds which, because of the design of the casting and the nature of the risers and vents, present maximum susceptibility to porosity.

Inadequate Mechanical Vents of Moulds

No one can lay down satisfactory rules for the venting of moulds except in general terms. The location of risers has much to do with this. We know that vertical vents are better than side vents in letting any gas escape quickly. We also know that it is not possible to provide too free an outlet for mould gases if we want to take every feasible means to prevent pinholes. It is much safer to use many vents than to take a chance on a small number.

Low Green Strength of Facing

This causes cutting or erosion, which in turn gives greater surface contact of the liquid steel with the individual particles of the sand mixture. Some of these particles may be readily converted into gas when the metal completely surrounds them, as it will ordinarily when bonded grains are broken away from the face of the mould proper. We can appreciate from this, that, while a weak facing sand causes cutting, it may at the same time create pinholes where the casting surface is the roughest. This striking combination of cutting and porosity has been seen on many castings made during epidemics of pinholes.

Low Dry Strength of Facing

Green facing seemingly should be capable of partially baking quickly as the result of contact with the liquid steel, so as to acquire or retain strength while becoming further heated in the pouring operation. If it has necessary strength it will of course retain its rammed form, and cutting will not result. If it crumbles while being heated, some of the trouble mentioned above may be experienced.

Oxidised Metal Parts of Moulds

These may be chaplets, chill plates, chill coils, rods, nails, wires, and other ferrous metal parts which have become rusty. Oxide that is caused by rusting, when in contact with liquid steel, forms gas that may often result in pinholes. In some foundries, rusty metal parts are more often found in cores than in moulds proper, due to the spraying of green cores in which horse nails or other metal parts are secured.

Moisture Condensation

The total moisture content of an entire mould may be satisfactory, while at the same time there may be an excessive amount of moisture on parts of the surface of the mould proper or in that portion of the mould forming the gate or sprue. This is often brought about by condensation. The longer a green-sand mould stands on the floor, the greater is the degree of condensation producible under ordinary shop conditions. This concentration of water on the inside surface of the mould should be carefully guarded against by as much opportunity as can be afforded for reasonable air-drying; also by pouring moulds as soon as possible after they are closed. When it is necessary to store closed moulds for many hours on the pouring floor, frequently it is advisable to lift off the copes and see that all portions are satisfactorily dry before the metal is poured.

Moisture condensation can be partially guarded against by using bent rather than flat sheets of metal or other material, which occasionally are employed as covers to prevent refuse from dropping into sprues and risers. A cover of this kind shaped so as to provide a liberal air space helps to prevent an early accumulation of drops of water on the under side of the cover above the down-gate. The presence of water here indicates that at least a part of the channel for the down-gate may be saturated. Such a condition invariably produces steam, which cannot help but be absorbed by the steel as it rushes into the mould proper. Pinholes customarily form under such conditions.

XUM

Poor Mixing of Ingredients

Suitable proportions of useful volatile matter, such as grain products of various kinds, may be carelessly distributed in the mixing operation, so that too much gas-forming material may be segregated. These lumps, made up largely of bonding material, may be rammed against a pattern in a location which is vitally dangerous from the standpoint of pinholes. Obviously the proper course is to see that every batch is properly milled according to a definite schedule, and that each batch is of the proper size to prevent overloading the mill. If the batch is too large for the mill capacity, the materials in it cannot be properly distributed in the time which is satisfactory for a batch of proper sizes.

Proportion of Farinaceous Binders

As has been pointed out, contact of the liquid steel with cereal binders produces gas, because such binders are readily combustible. If the green strength of the facing depends too greatly on such volatile materials and not sufficiently on clay and/or bentonite, a large amount of gas in the mould will naturally result, causing liability to pinholes.

Excess Volatile Matter in Cores

Occasionally cores contain a large total amount of gas-forming materials, due to the use of farinaceous, liquid, or pitch binders. Some cores are so shaped and/or placed in the mould that satisfactory outlet for the developed gases cannot be provided, if much gas-forming material is contained in the core mixture. This condition may result in an absorption of considerable gas by the steel and pinholes in the castings.

Dried Cores that Have Absorbed Moisture

When practice justifies the use of a baked core, it should be thoroughly dried and then stored in a way to prevent it absorbing an appreciable amount of moisture. It is well known that the use of an oil binder is preferable to other binders from this standpoint, although there are other factors such as cost which must regulate the choice of the binder.

When desirable mould conditions call for a core that should be thoroughly dry, and the core has been carelessly stored in a place that caused it to take up moisture, the extra amount of gas subsequently generated may result in considerable porosity.

Inadequate or Improperly Placed Core Vents

Probably the venting of cores cannot be overdone. In many cases, vents in cores are not as large as they might easily be made for maximum security against the entrapment of gas. Holes for such a purpose should be liberal in size, largely because small holes are so easily choked by accident (as when a small pebble may become lodged in the end of the vent hole). Every core contains some material that will produce gas when in contact with liquid steel. Metal flowing over a defective core forms gas which may not have a chance for complete escape, but may cause gas-laden steel finally to lodge in a part of the mould that is not close to the troublesome core. In this way, gas picked up by the metal from a core or part of a mould proper may result in pinholes in another part of the casting, deceiving the investigator as to the disturbing location.

Impurities in Sand Batches

Pinholes on one occasion were found to have been caused by particles of coal in the fireclay put into the facing sand. Fireclay deposits in the ground often immediately adjoin coal seams. When such clay is not skilfully mined and prepared for use, it may be mixed with coal fragments, which of course are volatile. Care should be taken to see that no material such as clay intended to be pure contains ingredients that might form gas that could serve no desired purpose but might be a cause of porosity.

Susceptible Design of Castings

Experienced steel foundrymen know that a casting may be of such design as to make it particularly susceptible to porosity. Often this seems to be due partly to a mould surface of large area compared with the weight of the casting. The greater number of square inches of green-mould surfaces that are in contact with the liquid metal, obviously the more opportunity there is for the steel to absorb gas from the mould. Castings that are of such designs as to cause extreme liability to pinholes should be made with extra precautions for venting as well as for every other manufacturing detail that may produce or confine gas.

In the case of many castings that seem inclined to have pinholes, skilful design of the gating arrangement is helpful. A gate that tends to force the gas ahead of the metal in a continuous flow is preferable from a porosity as well as from other standpoints. In some shops, certain castings which originally gave much trouble from porosity have been freed from this difficulty merely by changes in the design of the gates.

Factors that Favour Porosity

In the first part of this Paper mention was made regarding a condition which may now be briefly touched on as a closing comment. Apparently there is a very delicate balance which needs to be maintained between the combination of conditions that will prevent porosity and the combination of conditions that will cause it. One detail of foundry practice, among a good many, may get out of hand sufficiently to disturb the balance and throw the weight on the wrong side of the scale, resulting in pinholes. It may often happen that, when porosity occurs in very troublesome degree in the steel foundry, there are several causes operating in unison. The author's experience causes him to think that this condition usually prevails in times of porosity trouble, in plants making small steel castings in green sand, while pinholes in large castings poured in dried moulds probably arise more often from a single factor. Whatever may be the kind of steel casting under consideration, it is clear that more trouble for the producer is apt to result when several potential causes for gas cavities exist, as compared with a single cause. Thus, the inadequate venting of a large core and the condensation of moisture overnight in a sprue might cause pinholes, whereas the defect might not be occasioned by either one of these conditions if it happened to prevail alone in the affected mould. In similar fashion, the combination of a poorly-dried shank pot and an excessive amount of cereal binder or of moisture in green facing might throw the balance on the wrong side, while neither of these factors alone might have caused trouble. It would appear that every cause for pinholes, whether occasionally it can be positively identified as a primary factor or not, frequently may be a contributory one. The procedure logically suggested by this line of thought is unremitting skilful attention to every detail of foundry practice that is known or is thought to be controllable.

Expansion of Cast Iron

Researches by E. Söhnchen and O. Bornhofen, described in the "Archiv für das Eisenhüttenwesen," show that the coefficient of expansion of white cast iron decreases linearly with the increase in the carbon content. Decomposition of carbide increases the expansion coefficient, while the addition of large percentages of nickel has a similar effect on the coefficients of expansion of cast iron and steel. The addition of chromium first causes an increase in the coefficient up to a maximum of 0.5 per cent. Cr in the case of iron containing 3.5 to 3.8 per cent. carbon, but a larger percentage of chromium causes first a rapid and then a slower decrease in the coefficient of expansion. Aluminium and copper produce a linear increase in the coefficient.

Copper Curtailment Dangers

By "Onlooker."

Curtailment of copper output is in being, and although there may be doubts as to its duration, the trade is confronted with a reduction in world production on the basis of an annual paring down of 240,000 short tons. This, according to a published statement, is effective on current output, and scrutiny of available figures suggests that in a full year the 1934 total may be lowered by approximately 150,000 tons. The flow of copper from Empire sources, owing to the starting up of the Mufilira mine in Rhodesia and the by-product basis of Canada's position, will not apparently fall much, if anything, below last year's level, so that the sacrifice comes mainly from Chile and the Katanga property. So much for the "real" reduction, but in order to balance the total cut it is necessary to bring into the picture a scaling down in United States exports by about 50,000 tons per annum. This assistance to price maintenance, achieved through easing the pressure of sales on the London market, rests on no signature to a pact, but on what has come to be known as a "Gentlemen's Agreement."

This, in brief, is the arrangement announced at the end of March, and in anticipation of its vitalising effect on the copper situation, the quotation has already improved by about £7. What of the future? Sir Auckland Geddes has voiced his opinion that a low price assists consumption, and that demand must decline in the face of an unduly inflated value. This warning comes at an opportune moment, and will not, we trust, go unregarded by the industry. While standard copper stood below £30 there was more than a hint that the Aluminium Consortium was considering a price reduction, but since the turn such talk has ceased. In sober truth, copper to-day has many rivals, against whose attacks its resistance weakens in direct ratio to the rise in the price.

Opinions differ upon what constitutes the danger level for copper values, but in the writer's view the zone of uncertainty is entered as soon as the price of electrolytic passes £40, and at the present rate of advance it will soon be there. Actually the rise looks like going beyond that, and there is a very real danger that unless the curtailment arrangement is more flexible than it appears to be, the situation will get out of hand and chaos result.

Iron and Steel Import Duties

TEMPORARILY REDUCED TO FORMER LEVEL

Under the Additional Import Duties (No. 13) Order, 1935, issued by the Treasury on the recommendation of the Import Duties Advisory Committee, the increased rates of Customs duties imposed on certain elementary iron and steel products, which came into force as from March 26 last, under the Additional Import Duties (No. 6) Order, 1935, are temporarily reduced for a period of three months as from May 8, 1935, to the rates in force before that Order was made.

The Committee report that agreement has now been reached between the British Iron and Steel Federation and the Continental Steel Cartel for the temporary limitation of imports into this country from countries represented in the Cartel to a rate corresponding to the rate of imports from these countries in 1933. This limitation is for a period of three months, and is conditional on the duties applicable to these products being reduced during this period to the rates in force in January last. It is understood that during this period negotiations for a long-term agreement will be actively pursued.

Patternmaking Economics*

By H. STEAD

When speaking of patternshop economics, it should be borne in mind that they cover a wide area, embracing not only the most economical production of the pattern itself, but also the production of a pattern which will enable the foundry to produce a casting economically. It is quite natural and proper that the foreman of a department should wish to show how cheaply his own department can be run—but it is false economy when the foreman, in order to show low production costs, is forced to cheapen the production in his own department in such a manner that more expense is put on to another department, and this shows itself very quickly in the relations between patternshop and foundry. The foundry does not consist of the moulding only. The patternshop is an integral part of it and the first and last concern of the foundry as a whole is the economical production of good, sound castings, and the pattern which leaves the mould most cleanly and true to form, with the minimum of mending up to be done is the most likely to effect this result. This predicates a somewhat better finish on the patterns than the patternmaker, in his desire for cheap production, may feel disposed to give, or, if his method of production is subject to a higher authority, more than he may be allowed to give. Nevertheless, if it reduces the time spent on the moulding then the total cost will come to about the same figure, and the resultant casting will also approximate nearer to the sizes asked for by the designer. In short, the foundry, *i.e.*, the pattern and moulding shops, will have produced a correct casting quite as economically as would have been the case with a "jerry-built" pattern, a mould like a ploughed field, and much mending up. The excessive "mending up" of a mould necessitated by the state of a mould after the drawing out of a "jerry" pattern is essentially lost time, and should be a direct charge against the patternshop. The final cost of a finished casting is the important point—not the departmental cost—and a little extra time spent in the patternshop may be more than paid for often during subsequent operations in the foundry.

There are certain precautions, which might almost be termed elementary precautions, to which all patternmakers should be trained to give due attention. They do not always make for the cheapest pattern production, but they give more assurance of a correct casting. Unfortunately (from various viewpoints) they are not acted upon, and the result of cheapening the pattern is that the foundry has to make good any shortcomings. For example, the wiring on or dowelling on of loose pieces leads at times to these pieces being out of place and the subsequent casting may have to be scrapped, whereas the slightly lengthier process of dovetailing or blocking up and coring out—whichever best meets the case—would ensure a correct position being maintained. Which is the cheaper in the long run? A little more time on the pattern or making two castings to get one? Again—in shops where filleting is done with a blue pencil, all bosses should be made with a fillet round them, otherwise there is a chance (and it has been known to occur) for a boss to be mistaken for a coreprint—the casting appearing with a hole where the boss should have been—unpleasantness between the patternshop and foundry being the usual result plus another "scrapper."

Jointing of Patterns

There should be a limit to the use of the blue pencil in so far that parts of the pattern where the "draw" occurs should have fillets put in and in other portions one or two short pieces should be fixed to indicate to the moulder the size of fillet required. Projecting pieces on the top side of a pattern should be loose and dowelled on to ensure, as far as possible, that no part of the top is pulled down when lifting off. All sides of patterns which have to take the "draw" should extend the full depth of the pattern, so that in any case of drying in of the timber there shall be no projecting portions to pull up the mould. The jointing of patterns is a point too often neglected, either deliberately or for want of forethought, and wherever it is possible to find a plane on any pattern capable of showing a good flat joint, the pattern should be so jointed. It does, no doubt, cost more in some cases, but the benefit of so doing is felt by the moulder when the pattern is handed over to him. There can be no question that time and money is saved in the foundry when the moulder is able to make a flat joint instead of having to follow the contours of the pattern; also a much better draw can be obtained when drawing each half separately, as there is always a danger, when lifting the top part off a solid pattern, of pulling down the mould with the consequent unsatisfactory job of "mending up."

Another false economy is the use of green unseasoned timber. It is cheaper at the outset, but the consequent warping and distortion of the pattern causes bad "draws" and tempers in the foundry, whilst the requisite "mending up" puts up the cost in the foundry and mitigates against the casting being a good one.

The "One-off" Problem

Concerning the question of the "one-off" pattern, it is, no doubt, very commendable to cut down the cost of patternmaking as far as possible on work of this description. This, however, should be consistent with the production of a good mould. It is quite a recognised thing in setting a patternmaker on to a "one-off" job to say, "Don't make a fancy job of it—it is only for "one-off," and this statement, being taken literally by the patternmaker, leaves quite a lot of room for the moulder to demonstrate his skill, thus shifting the cost of the finished casting from the patternshop to the foundry.

Innumerable cases could be quoted wherein jobs which began as "one-off" have been sent, repeatedly, into the foundry. They come out for a second time with a kind of apology, to the effect that it was only for "one-off," but it will stand another—and so on and so on, each time getting worse and worse until the moulder becomes struck with admiration at his own skill in producing a casting from such an object. Any patternshop claiming to be up-to-date has in its outfit a number of the labour-saving devices, and as their purpose is to increase speed and efficiency, it should be possible to produce a pattern cheaply and at the same time one that does not require any apologies. Modern patternshop equipment has been brought up to so high a state of efficiency that any patternmaker really interested in his craft should be ashamed to find it necessary to apologise for his handiwork.

In any case, whether "one-off" or standard, it is another false economy to assemble the pattern with nails, and preference should always be given to screws. Initially, nails may be cheaper, both as to price and insertion, but two or three screws, rightly placed, are worth a dozen nails, and, should the pattern require alteration for a subsequent order, screws facilitate the alteration and the pattern suffers less damage in the process.

Due attention also should be paid to the construction of pattern and corebox when right- and left-hand are being produced from the same pattern, in order that this change may be made as simply and expeditiously as possible. There is often the contingency that one or two bosses may be missing, either lost or left in the core and put into the stove. Either way, new ones are required. Though all this may not cost much the first time, yet, if the pattern be sent into the foundry frequently, the cost is cumulative. If, however, the loose sides are marked out and all the bosses fastened on—then all the checker has to do is to take the sides and check both right- and left-hand whilst they are laid flat and accessible. All the coremaker has to do on taking away the box is to remove the two sides which have remained with the core, and in so doing he draws all the bosses at once; none is left behind, nor can any be lost. All that is then requisite is to place the two sides prepared for the opposite hand into the box, and in a few minutes, the alteration is effected.

In the building-up of patterns a thorough acquaintance with the possibilities of the various machines enables the patternmaker to effect economies in the time taken to do a job. Take, for example, the use of that handy tool, the dimension saw, in the building-up of cylindrical patterns. The most familiar practice is to cut blocks (or frames, according to the size of the job) carrying a number of flats, on which lags are laid down and fastened. A fair amount of time is taken up in marking out and cutting the flats. Then the lags all require fitting with the edges radial and the same width as the flats. The quicker method is to cut the blocks round. The lags, being narrower in this method, are bevelled on the jacket and the ends, where they are fastened to the blocks, are radiused out by pushing across the saw, the fence being set at right angles to it. The radiused portion is cut out to the width of the block, leaving a slight shoulder, forming a support for the block. Such examples as have been instanced form the general stock-in-trade of any patternmaker who interests himself in patternshop economics.

There are so many different types of work, as, for example, heavy trades, such as shipbuilding, machine-tool work, and electrical engineering, embracing castings from ounces to tons, both iron and steel; lighter trades, such as textile-printers' machinery, stoves and grates, etc. Whatever particular section of the industry may be under review, it will be found that the requisite patternmaking varies. Strickle work, both in green sand and loam, skeleton patterns, loose patterns, plate-plaster and metal patterns, to name a few. All of these varieties of the patternmaker's art have their own particular technique and problems, and a man who fully understood all of them would, indeed, be a master craftsman.

In general practice, it will be found that most patternmakers are familiar with one or two methods, and may have a smattering of the remainder, due possibly to their having served their time in some particular section and more or less continued in it. Patternmakers using wood as the medium for translating the draughtsman's designs into castings are by far the most numerous, and wood patternmakers who are also familiar with the technique of plaster work are very limited in number. Metal patternmaking is also a special branch. One can find a number of workmen who, calling themselves metal patternmakers, are merely pattern-filers, and indifferent ones at that. A really good metal patternmaker is hard to find, and, when found, should be treasured.

Skeleton Patterns

The skeleton method of patternmaking is one which is especially employed by shipbuilding firms and those engaged in the making of marine-engine cylinders and turbines. The skeleton is constructed, correct to shape in all its details, and is made so as to produce the exact metal thickness. Although patterns made by this method take a fair amount of time to construct and cannot, therefore, lay claim to a

* Extracted from a Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. W. N. Cook presiding.

great amount of labour-saving, yet they have several advantages, *e.g.*, a saving in timber is effected. The making of coreboxes is entirely eliminated so far as the main body of the casting is concerned, whilst at the same time the various thicknesses of metal called for in the design are more accurately produced. On the whole, it can be said that the making of skeleton patterns is a cheaper method than that of a solid pattern with its attendant coreboxes. A pattern for a large hydro-electric turbine casing has been dealt with. Mr Longden, in a Paper printed in a volume of the "Proceedings" of the Institute of British Foundrymen, put the job through by means of a series of strickles working from a number of centres, and the mould was made without any actual pattern. The brass trade has its own special technique, and a patternmaker engaged in this branch of the trade has to understand something concerning methods of machining the castings for which purpose it is necessary to put on to the patterns various pegs and centres to facilitate operations in the finishing department.

Plaster Patterns

Plaster is a very useful component in the patternshop, and Mr. R. Ballantine, a member of the Institute, in a Paper which appears in the "Proceedings," 1932-33, deals very fully with the uses to which this material can be put.

For the making of patterns for an article known technically in the textile trade as separators, and called in the foundry "blinkers," the castings are mounted in a row along a ring frame between the spindles, and are for the purpose of preventing cotton, revolving at a high speed on one spindle, from coming into contact with that on the spindles at either side of it. It is necessary that the separators should be very smooth to obviate any danger of the cotton sticking to them. The firm with which the author was connected at the time had, formerly, produced their own castings, but, finding certain founders in Staffordshire who could better them as to finish and price, these separators had been made by them for a number of years.

Then came a change in the management and the patternshop received instructions to prepare plates for producing the castings in its own foundry. The original patterns, split in halves, were found and mounted on two plates, six in a box. After a few trial casts, all of which showed a certain amount of "lipping" at the joint, it was found that, owing to the thin section of the half-patterns, when they were screwed down, the screws had a tendency to "spring" the patterns slightly one way or the other, thus causing a bad joint. Plaster was then brought into use. The half-patterns were sweated together accurately, a sand joint was made, and a plaster oddside was run on it. The patterns were then fastened in the plaster oddside and a dummy oddside of the other half of the pattern was run up. The resultant castings showed a very good joint with no "lipping," but the half of the casting corresponding to the metal pattern was quite smooth, whilst the half from the plaster dummy was rough and full of minute pinholes. Varnishing did not improve matters, but seemed to accentuate the holes in place of filling them up. Finally, acting on the advice of a good friend, a dummy oddside was made from asphalt with very good results, as this material will rub up to a glass finish with very fine sandpaper.

In the making of an experimental machine, small guards in aluminium were required to cover a series of small gears. These varied in length, the longest being about 3 ft. As the section was only $\frac{1}{8}$ in., it would have been rather a proposition to produce in wood and obtain an even thickness, so plaster was again brought into commission with success.

Rush Work

In a number of works it is customary, where a rapid delivery of an order is required, to send along to the patternshop preliminary drawings, the idea being that the patternmaker can "catch a start" and save time whilst the plans are reaching the final stage. This, although very well in theory, is not always good in practice. In some instances, it means that, having, as one thinks, almost finished, one is presented with the corrected and final plan, and discovers that one has only just commenced. The alleged small alterations may turn out to be large and annoying, and the time supposed to have been saved can be more than lost in making the necessary alterations. Alterations which may make a mess of the pattern, resulting in dissatisfaction to the patternmaker, his foreman and the moulder who has to work it.

The author has reached the conclusion, long ago, that the "preliminary" drawing is, in a number of instances, something of the nature of a "face-saver" to the drawing office, enabling them, when called upon to report progress, to say that certain patterns are in hand.

If good and cheap patterns are to be produced, which is the objective of all engineering works, one of the essential means to this end is to give the patternmakers good, clear drawings, with elevations, plans and sections of complicated parts shown so that an ordinary patternmaker can read them, and here again the "greater cost of the lesser price" comes into play. In order to save time and paper in the drawing office, it is customary in the bulk of drawing offices to issue the same drawing to the different departments. This means that the patternmaker has to work from a drawing containing a quantity of matter which is of no moment to him in the making of the pattern, but, on the contrary, may be a real hinderance. All that the patternmaker needs is a plain outline of the casting required (one that is not overloaded with a lot of extraneous matter), plus a set of dimensions given as directly as possible and not entailing dodging from one view to another, adding this and subtracting that, dodging across and up and down to arrive at the correct figure. True, by constant practice, a man can become amazingly expert at sizing up a job and arriving at a correct solution, but even then time is wasted in mental calculations which could be applied to the finishing of the work. This also is another of those cumulative costs, because in the subsequent checking the same performance has to be repeated.

With the modern demand for intricate castings, the drawings are also becoming increasingly intricate, and every possible means should be employed to make the "reading" of them as straightforward as possible, by eliminating everything which is not actually required in the production of the pattern. This is too much to expect, as it would entail preparing a special set of drawings for patternshop only, thereby putting extra cost on the output from the drawing office, whereas under the system of one drawing for all departments any extra cost is on the patternshop.

It may be counselling a perfection impossible of attainment, but how much better it would be if a set of finished drawings were sent into the shop along with the order. The job would then be done quicker and cheaper than is possible when working to "preliminarys," with the rest of the details dribbling in a few at a time.

In this brief outline of the ramifications of patternmaking the usual talk about imagination, visualisation and the like has been omitted—it being useless to labour the point—nor has any mention been made of equipment in the patternshop, as most foundrymen are no doubt conversant with the types of machinery in use. The author offers his sincere thanks to Messrs. Craven Bros., who, through Mr. Greenwood, Mr. Longden, Mr. Stafford and other members of the staff, have enabled him to collect portions of the data required for the purpose of this Paper.

DISCUSSION

After a vote of thanks had been accorded to the lecturer, MR. J. E. COOKE inquired whether the container corebox, which contained loose pieces as separate portions, was generally favoured by coremakers, particularly in connection with modern developments so far as oil-sand cores were concerned. It appeared to be useful at times to be able to have a side which would support the core while it was not sufficiently set to be transported to the stove. Mr. Stead appeared to suggest to coremakers generally that it was an advance in corebox-making practice which should prove to be of value.

MR. STEAD said he had not regarded the matter entirely from the standpoint mentioned. In the case of the method he had suggested the pieces would be kept together for whenever they were required. If there were any alteration in design, then it would be merely a matter of taking them off and fixing them where they were required elsewhere.

Drawing Office Weaknesses

MR. W. N. COOK was pleased to notice Mr. Stead's remarks with regard to the patternmaker considering how to make the pattern best for the moulder. This was not always the case, especially when the pattern was made by the firm ordering the casting, and when some other foundry had to make it. It was invariably made in the cheapest way possible. Both the staffs of the drawing office and the patternshop should have some knowledge of moulding. As a matter of fact, it was very rarely that the staff of a drawing office had any particular knowledge of patternmaking or of moulding, and this lack of knowledge very greatly increased the difficulties of the man who had to make the casting. Most draughtsmen considered that if they drew something that a pattern could be made from it and a mould made also. They had no knowledge of how it would draw or anything of that kind. A pretty-looking picture on paper was not necessarily the best thing to take to a patternshop.

MR. J. A. REYNOLDS thought that the general trouble was that most draughtsmen believed that they knew something about moulding and patternmaking and not the reverse. The lecturer had stressed the advisability of training, because in the future it might be necessary to have considerable numbers of skilled patternmakers and moulders. The trend of modern practice, however, was to produce the bulk of castings by repetition methods, so that he could not visualise conditions under which a greater number of highly-skilled men would be required, at any rate, in the patternshop.

MR. STEAD thought that Mr. Reynolds had somewhat misunderstood the point. Patternmakers should be trained to make patterns in whatever class of shop they found themselves; whether it was a fully-mechanised shop or one of the old *régime*, with a band-saw and an old lathe. They should be able to turn out a good job by hand, if necessary.

Substitutes for Plaster

MR. J. F. FAZACKERLEY (Newton-le-Willows) referred to the making of a wheel-guard. Had Mr. Stead tried the addition of Portland cement?

MR. STEAD replied that he had not.

MR. FAZACKERLEY said that what caused him to raise the point was that he was once faced with a proposition of a heavy plaster job when he had not sufficient plaster for the purpose. He used a three to one Portland cement with success, which gave a slower drying time and allowed a longer time for manipulating the strickles.

MR. STEAD said that the same effect could be produced with plaster by the addition of a little cornflour. This lengthened the time of setting, and also stiffened the plaster. In the particular case referred to, all that was required was one casting off, and then the plaster was broken up. He had also used a few drops of glue or size.

Mr. Ballantyne, in his Paper on the use of plaster in patternmaking, recommended a fusion of marshmallow for the same purpose; the more that was added the longer the setting.

The Outside Patternmaker

MR. J. E. COOKE asked what was Mr. Stead's experience with regard to people who exercised supervision over the construction of their patterns personally as contrasted with patterns which were purchased from people who specialised in their preparation and who had no foundry of their own.

MR. STEAD replied that not having had dealings with patternmakers except in seeing the results of their labours he was not competent to reply. From what he had seen of them, however, he thought some of them ought to cease manufacture.

MR. F. DUNLEAVY (Gainsborough) remarked that very often a half corebox or pattern was sent down which was entirely contrary in design to the principle of the job, accompanied with the remark "Will this do?" He remembered a few years ago a half corebox being sent down for a job which was 2 ft. 6 in. long. The core was about 3 in., and there were various bosses set in it. There was a $2\frac{3}{4}$-in. print to get away all the gases, and the remark was, "Will this do?" A pattern would come through and the rapping plates would be on the wrong side. There were scores of jobs of bad design through lack of foundry knowledge.

MR. A. SUTCLIFFE said the foreman patternmaker should himself be capable of producing a pattern that would give the best results in being moulded without reference to the foundry. It had been said that the moulder might have one idea and the patternmaker another, but there was only the best way, and the patternmaker should make it his business to see that he, as well as the moulder, knew which was the best way.

MR. STEAD replied that Mr. Sutcliffe did not allow for the fact that in many jobs there were always two or three different ways of moulding it. The patternmaker might have one idea of moulding it, and the moulder might have another. Some patternmakers employed master patternmakers who had never seen the inside of a foundry. All they thought they had to do was to make a pattern to a drawing. Certain moulders and certain patternmakers desired to keep the two sections of the industry in watertight compartments and not to co-operate with one another.

Machinery Allowances

A member raised a point with respect to patternmakers and machining allowance for castings. They seemed to have things all their own way in that respect. In the case of one casting his firm had made recently the machining allowance on the coreprint (and the core was only fastened in the bottom) was $\frac{1}{32}$ in., which he did not consider was sufficient. The patternmaker said it was enough if the core was in the centre. Some moulders, however, did not fit cores so accurately. It was a gunmetal casting and the core was about 2 in. dia.

MR. STEAD said that there was considerable difference of opinion with regard to machining allowance. One of the first things that a patternmaker had to ascertain when he went into a fresh shop was what was the general practice in that shop for allowance for machining. The shop with which he was associated at the present time allowed for much more machining than he had ever seen before. On the other hand, he had worked for a number of years in a shop in which $\frac{1}{8}$ in. was regarded as ample allowance for machining.

Factors Influencing Machinery Allowances

MR. E. LONGDEN (Manchester) agreed that machining allowance was a very controversial point. He thought the real point had been missed in connection with machining. Allowance depended upon the type of work which was being made in the first place. If it was a repetition line of casting, then, after trial and error, a definite allowance could be established; bottom minimum machining, and top side reasonable allowance to get rid of sullage and so on. In regard to jobbing lines of work it was necessary to exercise very great care. The patternmaker did not care to work to narrow allowances, since he was not sure he had got all his dimensions as correctly as possible. The moulder had to have sufficient allowances because of distortions and cambers. In the machine shops they required latitude because there may be no jigs or fixtures, and machining was very difficult if they were scratching on the skin of the casting. If a casting came from an outside firm it was better to play safe and put some more machining on it. On the other hand, with very heavy work, other problems were introduced. Machining could not be increased beyond a point, because if the surfaces were cast iron, and too much was taken off the metal, porosity difficulties would be experienced due to penetrating to the core of the metal. A further complication would be that, if having to comply to a hardness test, the value would be lower with every increase in machining allowance. Machining allowances with respect to repetition castings were a relatively simple matter, but in the case of a large casting, where cleanliness was essential, it was not practicable to run the risk of a $\frac{1}{16}$-in. or $\frac{1}{8}$-in. machining. Camber and distortion had to be taken into consideration too.

MR. F. L. TOPHAM (Bolton) suggested that the introduction of oil sand modified coremaking.

MR. A. HOPWOOD (Wilmslow) remarked that there was not a corebox made for a naturally-bonded sand which could not be made up in some type of oil sand, and there was no need for the modification of boxes except perhaps to simplify.

International Foundry Congress

The International Foundry Congress, which is being organised by the Belgian Foundry Technical Association, is being held at Brussels from September 20 to 25, 1935, and will coincide with the International Brussels Exhibition, the opening of which will attract a large number of visitors to Belgium. The Congress will comprise technical sessions, works visits, receptions and various ceremonies, finishing with a sightseeing tour.

A large number of foundrymen from Belgium and elsewhere have signified to the general secretary their intention to participate in the Congress. The subjects of the sessions are given below, and the discussions at them will constitute a valuable contribution to the science and art of the modern foundry.

The following subjects are on the agenda:—*Steel Foundry.*—(1) Composition, properties and development of special steels; (2) study of the soundness of castings. *Ironfounding.*—(1) Influence of the composition of iron on the mechanical properties, tensile strength, casting life, corrosion and machinability; (2) test for the standardisation of test-pieces for "life" tests. *Malleable Foundries.*—(1) Classification of castings, testing methods and inspection; (2) possible applications of malleable. *Non-ferrous Foundries.*—Castings in metal chills, ferrous and non-ferrous metals.

Those intending to participate in the Congress should write to the general secretary of the Congress, 57, rue de l'Academie, Liége, Belgium, for particulars and registration forms.

THE ENGINEERING and ironfounding firm of Messrs. J. Bisset & Sons, Limited, Greenbank Works, Blairgowrie, Perthshire, this year celebrates its centenary.

The Weathering and Corrosion of Glass by Water, Acids and Alkalis

(Concluded from page 327.)

much good—the visible test. This, of course, applied to those enamels which withstood acid attack altogether. It was a crude method admittedly to put acid on the enamel and then examine it for any effect, and even then accurate results could not be obtained, because for one thing it would not distinguish between two enamels which were fairly near to the resistant point.

Acid-Proof Enamels

MR. W. BALL (Blythe Colour Works), in proposing a hearty vote of thanks to the lecturer, said he thought some of the members hardly expected that the points raised would be so relevant to their own problems of acid-proof or acid-resisting enamels as they had turned out to be. Nor did he think that some of them fully realised that the vitreous enamels which they used were glass; or, as their experts would say, glass fused on metal. Several of the points raised would be of very great assistance to many of them in the production of the kind of enamel which they so much desired. He might say in regard to German acid-resisting or acid-proof enamels, that he did not think any of them who could produce an acid-proof enamel had anything to be proud of, because several of the older members of the industry would tell them that they were using these enamels 25 years ago. The factor they now had to discover was how to make acid-resistant or acid-proof enamels which the enameller could work reasonably well. In regard to a test for acid-proof enamel, he hoped the chemists present would not mind him saying that the enamellers and enamel manufacturers would be very pleased if they would formulate a test for acid resistance rather than have some gentleman from the office cutting a lemon in two and putting it on to see the effect.

MR. HOBLEY (Emscote Foundry Company) seconded, and the vote being carried, MISS DIMBLEBY, in reply, referred again to the highly-resistant quality of zirconia, but glasses containing it were difficult to melt and they could not consider using it commercially except in limited amounts.

German Foundrymen's Technical Association

The annual general meeting of the German Foundrymen's Technical Association is to be held on Saturday and Sunday, June 1 and 2, in Berlin. The following Papers will be presented:—"Wear Tests on Alloyed and Plain Steel Castings," by Dr.-Ing. K. Roesch; "Non-Ferrous Centrifugal Castings," by Dipl.-Ing. A. H. Ludwig; "Blowholes in Castings with Special Reference to Steel Castings," by Dr.-Ing. E. Krupp; "The Influence of Hydrogen on Cast Iron," by Dr.-Ing. Baukloh; "The Influence of Phosphorus on the Mechanical Properties of Grey Cast Iron at Elevated Temperatures," by Dr.-Ing. Bischoff; "The Influence of Alloy Additions on the Structure and the Tensile Properties of Cast Iron," by Prof. Dr.-Ing. H. Uhlitzsch, and "Technology, Industry and World Philosophy," by Civil Eng. Karl Kasper. Further details of this meeting can be had on application to the Verein deutscher Giessereifachleute, 100, Friedrichstrasse, Berlin, N.W.7.

Aluminium Paint in Moulds

Chill plates, which form the bottom face of the moulds in which automobile-engine-valve tappets are cast, are prevented from developing a film of rust by the application of a coat of highly-refractory aluminium paint.—"Steel."

The Need for Standardisation and Uniform Thought in Welding Subjects*

By O. SIMONIS

As everyone knows, standardisation has been successfully applied to very many units which make up the engineering industry, and it is the author's object to emphasise the need for this in connection with as many phases of welding as possible, to create a more general "welding-mindedness," to point out some of the existing inconsistencies and to submit some remedial suggestions.

In the first place, what is to be the meaning of the term "welding electrode" or "electrode" by itself relative to welding? It seems to be far too widely used at present. Is a piece of bare wire, or a wire that is fluxed with a thin solution of china clay or the like, entitled to be called a "welding electrode"? The author suggests that it cannot be so described. It is submitted that the term welding electrode should only apply to a wire which has a metallurgical or other scientific coating which increases the gauge of the wire itself by not less than 20 per cent., and that there should be a universally-accepted distinct differentiation between bare-wire welding, fluxed-wire welding and electrode welding.

Distinguishing Colours

One would like to see the very unsatisfactory practice of colouring electrodes for distinction in haphazard fashion, according to the fancy of each manufacturer, discontinued. Distinguishing colours should be universally recognised for the definite different materials to be welded; thus, one could use one colour for mild steel of tensile strength up to 28 tons; one for mild steel of strength greater than 28 tons; one for cast iron leaving a hard surface; one for cast iron leaving a machinable surface; one for manganese steels; one for nickel-chromium steels; one for stainless steels, etc. If such a definite system were universally adopted the user of electrodes and the welder would automatically know what he had got in his hands, whether the particular electrode was of one make or another.

The different forms of quantity units are also very confusing to the buyer at present. While it may be said that the majority of electrode suppliers have adopted the standard Birmingham gauge and the thousand-foot unit, this is by no means universal, and certain firms express quantities by weight or use fractional-inch measurements in place of the gauges. This could easily be standardised by adopting the present majority policy.

Equally confusing are some of the descriptions of characteristics; for example, if an electrode is stated to have a certain percentage of elongation this might mean over 2 in., 4 in. or 8 in.; or over a length equal to the square root of the cross-sectional area, and might refer to a butt weld or an all-weld-metal piece; here also we need an accepted standard.

The foregoing issues could be settled by co-operation between the electrode manufacturers, but it is regrettable to note that they seem as yet to have abstained from any joint action for the formation of an association to help the problems of the industry, and seem to be waiting for outside pressure.

Tests and Regulations

A different and more difficult side of the subject is the question of the tests and regulations by which the actual quality and efficiency standards of the material are to be determined. As yet no two committees or bodies of experts seem to have had views which even approach uniformity. A very good example is to be found in shipbuilding. The test requirements of the two leading classification societies—Lloyd's and the British Corporation—differ substantially, and as a third party the Admiralty goes its own way. The latter, however, very fairly tests at its own expense, but the two Corporations throw the expenses, which are considerable, on the industry, and neither of them will take any notice of what is done for or by the other. How many test regulations have to be expected in the development of constructional welding is as yet an open question, but they also threaten to be several, and no less than three committees are already in existence and are trying to draw up regulations without as yet any declared co-operation between themselves. Surely all this labour and endeavour to establish test standards and regulations should be placed under the control of one central body. Such body should, as one of its foremost duties, establish uniform tests under uniform conditions, so that a test of a weld material is in fact a definite test to a standard as established for many other materials, and is not side-tracked by developing into a test of human material. When, for example, classification societies demand their tests to be carried out in a shipyard, such tests are liable to become—at least partly—tests of personnel, for many shipyards are, as yet, not employing what could be termed high-class welders, but are working with apprentices; in fact, there are no means anywhere available as yet to establish what is an efficient welder or to grade welders, and this, it is submitted, should also be the accepted duty of such a central organisation. Every inspector, surveyor or charge hand (and this might possibly even be extended to the actual welder), should be able to produce an efficiency certificate showing his fitness for such and such important work. Similar lines have been adopted in certain other countries. The not infrequent practice of sending a foreman—who may be a caulker, boiler-maker or other mechanic—to a course of welding, and then making him responsible for the welding of important work, is dangerous and should be made impossible. Nobody can become a responsible welder by undergoing a course of a few weeks' duration or with the aid of a correspondence school. A welder should possess the skill of a craftsman, just like any other artisan, and a welding engineer should be required to possess qualifications, just as must a mechanical, civil or constructional engineer.

In considering the question of uniform tests of material, such as weld metal that is being deposited, considerable modification of thought is desirable, bearing in mind the class of work the metal is to weld, and a few items will be pointed out which, in the author's opinion, have so far not received the attention they deserve. For example, in structural welding, forgeability has been neglected, thereby giving proof that the weld metal is not hot-short; so far, this does not seem to have formed part of any tests. If, for example, a welded warehouse full of combustible material is not to collapse in the event of a fire, adequate resistance of the weld metal to heat is an all-important factor. Elsewhere equally important would be the resistance to fatigue—for example, in the welding of rolling stock which is submitted to constant shock under the practical conditions that it will meet in service. Such practical and service considerations are in many respects much more important than (for example) the very impressive all-weld-metal elongation tests which now form part of several regulations but represent conditions which in practice do not occur, and on the value of which there exist admittedly entirely different views.

In speaking about tests, the author is far from suggesting further conditions or complications of these—the very contrary is the case. Tests for the material as well as for the welder should be as simple as possible, and be reduced to a minimum. Except for Izod values, the time-robbing all-weld-metal tests should be discarded. For most purposes it should suffice to have tensile tests simultaneously with the elongation reading, say, over 2 in., so as to include the weld metal, and such tensile tests would give more valuable information if they were so arranged that the break must take place in the weld metal (shear tests excepted), thereby allowing the latter to be examined and, where necessary, the gas contents determined. The break in the weld can be variously assured, *e.g.*, by drilling a proportionate size of hole into the centre of the weld metal of a butt weld, or by a one-sided lap weld. For the bend test a longitudinal butt weld, machined level, using narrow metal so that the proportion of parent metal to weld metal is not above 3 to 1, would give a highly practical result, as in this form the weld metal would have to bend parallel with the parent metal. Such special tests as the suggested forging and fatigue tests should be added only for such classes of work as may meet corresponding conditions in practice.

Rolled Sections for Welding

A word should be said about the steel-rolling mills which will presently play an important part in facilitating structural welding. No attempt has yet been made to develop sections particularly adapted to welding, but it is not too early to suggest that action in this respect should be taken (and on standard lines) so that one does not get the different rolling mills branching out independently and adding to the general chaos.

The author ventures to estimate that the welding industry as a whole consumes at present in the neighbourhood of 400 million cub. ft. of oxygen per annum, in which is included the oxygen which is required for cutting metals preparatory to welding, while it also consumes over 200 million ft. per annum of bare wire, fluxed wire and electrodes in metallic-arc welding. Excluded from these figures are filling rods used in connection with the oxy-acetylene process. Most people will probably be astounded at the magnitude of these figures, but it may be said that they are sufficiently correct to show the vast employment of welding to date; so vast that it seems to justify the attempt to solve the problem with which this Paper deals, and it also explains why so many interests are represented here.

It must be granted that up to a point the British Standards Institution seems to be organised to deal with many of these matters, but it has no testing station or examination facilities, and has in any case failed to persuade the other organisations which have such facilities to co-operate, and the conclusion one might derive from this is that a new central body needs to be created for the central control, which might co-ordinate the various existing units and institutions for our purpose and take the full responsibility for the standardisation and unification of the welding industry as a whole.

* Paper to Welding Symposium (Group 4) organised by the Iron and Steel Institute and held in London, May 2 and 3.

General Refractories, Limited

Following the acceptance by shareholders of Messrs. J. Grayson Lowood & Company, Limited, of the offer for their shares made by General Refractories, Limited, the latter is to increase its capital to £350,000 by the creation of 200,000 ordinary shares of 10s. each. Of these, 100,000 will be offered to holders in the proportion of one for every five held. The increase of capital is necessary to provide the shares to be issued in exchange for Grayson Lowood shares and cash for this and other enterprises. The balance of shares will be held in reserve. A meeting held at Sheffield on May 14 approved the capital proposals.

ABOUT PIG IRONS!
You should have This

This newly-published twenty-four page Brochure contains useful information about Pig Irons. Every foundryman should have his copy.

The thumb index opens at these sections :—

- Hematite Pig Irons—Fractures and Analyses.
- "UCO" All-Mine and Cylinder Irons.
- Sizes of Pigs.
- Refined Pig Irons—Fractures and Analyses.
- Ferro-Manganese and Spiegeleisen.
- Shipping Facilities.

WORKINGTON IRON & STEEL COMPANY

Branch of
The United Steel Companies Limited

WORKINGTON CUMBERLAND

PLEASE USE THE COUPON BELOW.

THE UNITED STEEL COMPANIES LTD., PUBLICITY DEPT., SHEFFIELD, 10.

Please send.....copies of Booklet, Ref. No. W.175.

Name.....

Firm's name and address.....

.....

Position in firm.....

THE UNITED STEEL COMPANIES LTD

RD W17

This Week's News in Brief

Trade Talk

THE FIRST CONSIGNMENT of Russian pig-iron ever imported into the United States arrived recently for distribution to points on the Atlantic seaboard.

A PETITION HAS BEEN PRESENTED to the Court of Session on behalf of the Atlas Steel Foundry & Engineering Company, Limited, Armadale, for the confirmation of the reduction of capital from £75,000 to £37,500, as resolved at the extraordinary general meeting on April 10.

THE CLYDE CRANE & ENGINEERING COMPANY, LIMITED, of Mossend, have secured an order for 10 cranes for the Lyttleton Harbour Board of New Zealand. The value of the contract is in the region of £40,000, and the cranes will be constructed under the latest patents of the company for special harbour purposes.

LORD ABERCONWAY formally presented to the Royal Academy on behalf of Firth Vickers Stainless Steels, Limited, recently, the stainless-steel turnstiles and counters which were made by Messrs. G. Johnson Bros., for the Exhibition of British Art in Industry, held at the Royal Academy in January and February last.

THE ANNUAL MEETING of the Crucible Steel Makers' Association was held at Sheffield last week. The President, Mr. W. E. S. Patrickson (Messrs. B. Huntsman, Limited), retired, having held the office for six years. Mr. L. Chapman (Messrs. W. Jessop & Sons, Limited) was elected President for the ensuing year.

PRODUCTION OF HEMATITE PIG-IRON, with the lighting of another furnace at Moss Bay at Workington, is at the highest level it has reached since 1921. There will be a slipping-back from the peak when the furnace changes over first to spiegel and then to ferro, but the important point is that the larger make is being promptly absorbed, and that is an indication, of course, how favourably affairs continue to go in the North-West Coast hematite pig-iron trade.

SPEAKING AT THE 82nd anniversary festival of the London Association of Engineers, Sir Alfred Herbert said that engineering was not responsible for unemployment. He refused to believe in overproduction until he was convinced that every man, woman and child on this globe had at least sufficient of the necessities of life and a very considerable margin of the luxuries as well. Until that was brought about they, as engineers, would be quite content to go on saving labour and continually raising the standard of living.

MESSRS. DAVID BROWN & SONS (HUDDERSFIELD), LIMITED, have designed and manufactured to the order of Messrs. Hudswell, Clarke & Company, Limited, Leeds, a forward and reverse reduction gearbox for the miniature Diesel locomotive made for the Blackpool Pleasure Beach. The drive is supplied by a 32.5-h.p. two-cylinder Diesel engine. The forward and reverse sliding gears, mounted on the input shaft, and the corresponding fixed mating gears mounted on the wormshaft, are of the straight-tooth spur type made from nickel case-hardened forged steel. The final reduction is made by a high-efficiency wormgear, embodying a centrifugally-cast Taurus bronze wheel, mounted on the axleshaft, and a nickel case-hardened forged-steel worm, formed solid with its shaft. All the gears, which are totally enclosed, are mounted on high-tensile forged-steel shafts running in ball and roller bearings.

AS ANNOUNCED on this page last week, the first mechanically-charged blast furnace in Scotland is in blast at Messrs. Colville's Clyde Iron Works, near Glasgow. The furnace has been designed for a daily output of 300 tons. This is claimed to be the most economic capacity for Scottish conditions, and is in accordance with the opinion stated by Dr. McCance in the course of his presidential address to the West of Scotland Iron and Steel Institute last October. He claimed that large furnaces, such as were common in America and Germany, with outputs of 1,000 tons per day, were too large for Scottish conditions. About 18,000,000 cub. ft. of gas of low calorific value will be produced per day. This gas will be cleaned in a new electro-static dust-removing plant now on the point of completion, and which is claimed to be the first of its type erected in Britain. The gas will be conveyed across the Clyde to the Clydebridge steelworks and used for steelmaking purposes. Clyde Iron Works has previously been the scene of experiments which have revolutionised the Scottish pig-iron trade, as it was here that James Beaumont Neilson introduced the use of hot blast in 1828. The complete scheme of reorganisation and modernisation which is contemplated at Clyde Works will cost approximately a quarter of a million sterling.

Company Reports

Monk Bridge Iron & Steel Company, Limited.—Profit for 1934 of £3,217, which had been written off the debit balance carried forward, reducing it to £162,232.

Partington Steel & Iron Company, Limited.—Net loss for 1934 of £13,673, increasing the debit balance carried forward to £95,886. The dividend of 5½ per cent. declared on the non-cumulative second preference shares of the Lancashire Steel Corporation will be included in the accounts of the company for 1935.

British Oxygen Company, Limited.—Profit, after providing for full depreciation and all standing charges, £357,879; brought in, £45,171; available after payment of half-yearly dividends on the preference and ordinary shares, £304,266; final on the ordinary shares of 11 per cent., making 15 per cent., £182,282; to reserve, £75,000; written off value of shares in subsidiaries, £25,000; carried forward, £21,983.

Contracts Open

Belfast, May 22.—100 cast-iron medium lamp columns and arms, for the Town Council. The Engineer and Manager, Belfast Corporation, Gasworks, Ormeau Road, Belfast.

Liverpool, May 23.—Supply of about 1⅓ mile of 54-in. bitumen-lined steel pipes and a number of specials and cast-iron pipes, for the Town Council. The Water Engineer's Office, 55, Dale Street, Liverpool, 2. (Fee £5 5s., returnable.)

London, July 1.—Two vertical high-compression heavy-fuel oil engines, with centrifugal pumps and appurtenant works, at Hornsey Pumping Station, High Street, Hornsey, London, N.8, for the Metropolitan Water Board. The Chief Engineer, Metropolitan Water Board, 173, Rosebery Avenue, E.C.1.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Housing Castings, Limited.—Capital £100. Subscriber: G. M. Rhodes, 172, St. Vincent Street, Glasgow.

Shurmer & Brown, Limited, Cambridge Street, Sussex Street, Lower Broughton, Salford.—Capital £1,200. Sawmill engineers, founders, etc. Directors: T. Shurmer and F. Brown.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"FOSTRYT."—Firebricks and fireclay articles. Pickford, Holland & Company, Limited, Eclipse Ganister Works, Attercliffe Road, Sheffield.

"ATOMMOL."—Insulating bricks, furnace blocks and firebricks. Harvester, Limited, 67, Queen Victoria Street, London, E.C.4.

Electric-Furnace Slags

A. WEJNARTH, in the "Transactions of the Electrochemical Society," describes measurements of the electrical conductivity of synthetic slags containing varying proportions of silica, iron oxide and lime, the values being determined at different characteristic working temperatures.

Personal

SIR WILLIAM BARCLAY PEAT has been elected chairman of the Council of the Tin Producers' Association in place of Brigadier-General Sir Samuel Wilson, who has resigned.

MISS LENA ALLAN, a member of the staff of Messrs. Douglas Fraser & Sons, Limited, Westburn Foundry, Arbroath, was the recipient of gifts from her colleagues on the occasion of her marriage.

MR. C. H. SPARKS, of Messrs. Stooke & Sparks, Limited, builders' ironfounders, of Grays, Essex, celebrated fifty years in business in the iron trade on May 1 by a dinner in London, at which numerous friends were present.

MR. ROBERT LOWE has joined the staff of Messrs. G. D. Peters & Company, Limited, Windsor Works, Slough, in connection with their activities in the production of special alloy irons, such as Monel, nickel-chrome, etc., for heat, wear, acid- and corrosion-resisting, and also in connection with their non-ferrous castings for all purposes.

MR. A. C. FALL, of British Timken, Limited, Aston, Birmingham, who recently visited Australia to superintend the fitting of more than 200 bearings to coaches of the Queensland Government Railways, is now proceeding to New Zealand, where he is to superintend the fitting of the 264 axleboxes which were recently ordered from Birmingham.

Obituary

MR. GEORGE SAMUEL BAKER, a director of Messrs. Baker Perkins, Limited, engineers, died recently, at the age of 74.

MR. JAMES EDWARD WASHINGTON, manager of Messrs. John Bagnall & Sons, Limited, Leabrook Ironworks, Wednesbury, died on May 2.

MR. ARCHIBALD BROWN, founder of the firm of Messrs. Archibald Brown & Company, Limited, brassfounders and coppersmiths, of Liverpool, has died, at the age of 67.

MR. TOM DOWNS, of Barton-on-Humber, who has died, aged 75, was a member of the family associated with the Hull engineering firm of Rose, Downs & Thompson, Limited. After serving an apprenticeship with the firm, Mr. Downs managed engineering works at Grimsby, and about 40 years ago went out to Malta to take charge of works there owned by family connections. Since his retirement he had lived at Barton.

Glasgow City Exhibition

The Lord Provost of Glasgow recently opened an exhibition in the Kelvin Hall, Glasgow, which has been organised for the purpose of demonstrating the progress and development of municipal government during the past century. The exhibits show the activities of various departments of the Corporation. The largest group of exhibits is from the Education Department and includes work from the continuation and trades schools administered by the Corporation, such as building, sheet-metal work, plumbing, structural engineering, printing, welding, patternmaking and foundry work. The two latter subjects are illustrated by full-size drawings on boards, and a large selection of patterns and coreboxes made by students of the first-, second- and third-year courses of the City and Guilds Certificate curriculum. There is a large dry-sand mould of a slide-valve cylinder fully cored with the cope lying alongside ready for closing, and three plaques of the city arms cast in aluminium alloy, statuary bronze and high-tensile bronze. There are a number of running and chilling test-pieces and a series of blocks showing the drawing properties of aluminium alloys and high-tensile bronze and the result of casting with and without chills, risers, etc., and with combinations of these, which have been made by the students in the course of the past session.

Forthcoming Event

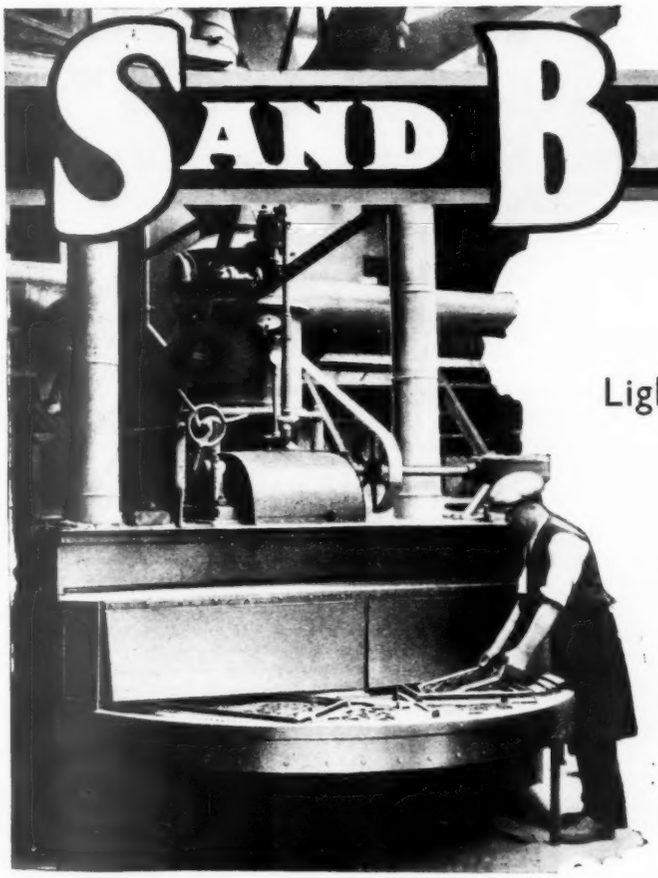
The Institute of British Foundrymen

MAY 25.

Lancashire Branch:—Visit to the works and foundries of Messrs. Howard & Bullough, Limited, Accrington, at 2.30 p.m.

XUM

SAND BLASTING



Secures Sales

Light Castings should be cleaned on a

Rotary Table

But it must be a

GUTMANN

Suppliers—

T. Fearnley Allen & Son,
Norwich Union Chambers,
Birmingham, 3.

Tel.: CENTRAL 4038. *Grams: "SANDBLO. B'HAM."*

CAST IRON FLANGED PIPES

2 in.—12 in. & CONNECTIONS. to 24 in. dia.

WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.

JAMES & RONALD RITCHIE, LTD.,

Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

BRANDS:-
"DALZELL" "GLENGARNOCK" "CLYDE" "MONKLAND"
SPECIAL & ORDINARY FOUNDRY QUALITIES & FORGE SPECIAL REFINED
WITH TOTAL CARBON GUARANTEED NOT EXCEEDING 3¼ MAX.
• HIGH GRADE HEMATITE PIG IRON •
'PHONE CENTRAL 9280'
COLVILLES LTD
'GRAMS "COLVILLETT" GLASGOW
195 W. GEORGE ST., GLASGOW.
WRITE FOR OUR ILLUSTRATED BOOKLET

Raw Material Markets

A steady volume of business is being put through in the iron and steel trades. The consumption of pig-iron is maintained at a good level, increased activity being reported in several of the chief iron-consuming trades, the light-castings branch in particular. Finished steel is in increasing call. Those works producing steel bars and strip will, of course, be affected by increased imports from the Continent under the new agreement, but at the moment they are very busy.

Pig-Iron

MIDDLESBROUGH.—Ready disposal of the output of pig-iron in this area is assured by the contracts which makers already have on their books. As the majority of these arrangements do not expire until the end of the half-year, new bookings have been rather limited, although more activity should be witnessed next month. Stocks of iron at makers' works are reported to have been reduced to a very low level. Producers adhere firmly to the agreed minimum prices, which, in the case of Scottish deliveries, are 1s. 3d. per ton higher than the delivered prices of Midlands iron. The quoted prices of No. 3 Cleveland G.M.B. (with the usual differences for other grades) are 67s. 6d. per ton delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow.

Although there is quite a heavy demand for East Coast hematite, particularly from Sheffield and the Midlands, there is no lack of available supplies, and the makers would welcome a steadier demand from South Wales and from the export markets. Two furnaces are now undergoing repairs, and it is hoped that the demand will revive sufficiently to justify putting them into action. The export price of No. 1 East Coast hematite is decontrolled, and 63s. 6d. is only indicated as an approximate figure. For home sales the fixed prices are 69s. per ton delivered Middlesbrough, 71s. delivered North-East Coast, 75s. delivered Scotland, 75s. to 78s. delivered Yorkshire, and 79s. delivered Birmingham.

LANCASHIRE.—Midland ironmasters report that they are making steady deliveries of foundry iron to this area, and that there are signs of a seasonal acceleration of activity in the light-castings trade. Most manufacturers of machine tools and heavy electrical plant continue to be well employed. The market remains very firm, with Staffordshire, Derbyshire and Lancashire brands of No. 3 foundry iron equal to Derbyshire all quoted for delivery to users in the Lancashire zone on the basis of 74s. per ton. Northamptonshire brands being on offer at 72s. 6d., Scottish foundry at from 81s. 6d. to 82s. 6d., West Coast hematite at around 78s. 6d., and East Coast hematite at from 75s. to 76s., according to quality.

MIDLANDS.—Considerable tonnages of No. 3 iron are available at the furnaces in this area. The demand from the consuming trades is up to a fairly satisfactory level, although activity in the light-castings trade has not expanded as was expected. Within the last week or so there have been signs of better employment in this direction, however. The controlled price, delivered Birmingham and Black Country stations, for Northants No. 3 is 67s. 6d., and for Derbyshire, Lincolnshire and North Staffordshire No. 3, 71s. These prices are subject to graduated rebates to large consumers. The price of forge iron is unchanged at 5s. per ton below the above levels. There is a little more business moving for forge iron, and the outlook is slightly better. Prices of the irons used in the general engineering trade, although without control, are very firm, but they vary widely for various reasons. The total tonnage consumed locally is considerable. Low-phosphorus pig-iron is offered at between 85s. and 87s. 6d. per ton, including Scottish at 85s. and medium-phosphorus at 72s. to 80s. For special refined irons, quotations range from £5 7s. 6d. to £7, delivered this area. There is very little new buying, as the majority of consumers are covered for a little while ahead.

SCOTLAND.—The demand for Scottish foundry iron on the Glasgow pig-iron market has not been very active, but prices are firmly maintained at 70s. f.o.t. furnaces for No. 3 and 72s. 6d. for No. 1. There are now twelve furnaces in blast here, an additional stack having been lighted for the purpose of making basic. The light-castings founders remain busy. No. 3 Cleveland iron is 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow, other English foundry iron being 1s. 3d. per ton below these figures.

Coke

Buying of foundry coke is not very active at the moment, as foundries are inclined to await a fall in quotations before making extensive purchases. So far, there have been no changes in values. In the Birmingham area, best Durham coke is offered at from 36s. to 40s., according to analysis and tonnage, and Welsh from 34s. to 43s. 6d. Small quantities of Scottish coke come into this area, and are offered at round about 40s. per ton.

Steel

Busier conditions have developed in the steel markets than have ruled since the early part of April, states the official report of the London Iron and Steel Exchange. The temporary agreement between the British and Continental steelmakers has been followed by merchants and consumers buying more freely, and although there has been no change in prices, quotations in all departments have been firm. Business in the semi-finished steel market, which has been indifferent for some weeks, has expanded, and the works producing this class of material are busily employed and are making good deliveries to consumers. Some forward transactions have been reported recently, and the volume of orders reaching the works shows a tendency to grow. Business in Continental semi-finished steel is restricted to importations against old contracts. There has been a better demand lately for finished steel, and although the greater part of the business placed has been on home account, the export trade in this class of steel seems to be expanding. The improvement is spread over the market, and there has been a fair amount of forward buying.

Scrap

In the Cleveland district heavy machinery cast-iron scrap broken into cupola sizes is offered at 55s. per ton; a fair demand from the foundries for heavy metal is reported, prices ranging from 52s. 6d. to 53s. A steady call for cast-iron scrap is reported from the Midlands, where heavy machinery metal in cupola sizes is quoted at 55s. to 57s. 6d., good heavy at 50s. and clean light at 47s. 6d. In South Wales, good cast-iron machinery scrap for foundry purposes is only in poor local demand at 52s. 6d. to 55s. In Scotland, on the other hand, where the foundries are generally more active, there is a good inquiry for machinery cast-iron scrap in pieces suitable for their cupolas at 56s. 6d., with ordinary cast-iron scrap to the same specification 52s. 6d.

Metals

Copper.—A number of factors have combined to bring about a strong demand for this metal during the past week. The inauguration of the restriction scheme found the market in an optimistic mood; a number of consumers decided that the time had come to purchase rather more heavily than they had been doing. At the same time, copper has been in demand for investment purposes on the Continent, owing to fears of currency breakdowns.

Quotations have risen steadily, and, although some slight setback may occur, it seems that the upward tendency of the market will continue for some time.

Daily market prices :—

Cash.—Thursday, £32 17s. 6d. to £33; Friday, £33 3s. 9d. to £33 5s.; Monday, £33 8s. 9d. to £33 10s.; Tuesday, £33 15s. to £33 16s. 3d.; Wednesday, £33 8s. 9d. to £33 10s.

Three Months.—Thursday, £33 6s. 3d. to £33 7s. 6d.; Friday, £33 11s. 3d. to £33 12s. 6d.; Monday, £33 17s. 6d. to £33 18s. 9d.; Tuesday, £34 3s. 9d. to £34 5s.; Wednesday, £33 17s. 6d. to £33 18s. 9d.

Tin.—Dealing in tin on the London Metal Exchange has been greatly limited by the lack of supplies.

Regarding the recent protest by dealers against the "artificiality" of the market, Messrs. Rudolf Wolff & Company state: "It must be frankly admitted that there is a considerable annoyance and irritation, which is by no means confined to the 'bears,' who may find difficulty in covering their 'shorts,' but is shared by brokers, dealers and arbitrage houses, whose legitimate business has been practically destroyed, or hindered, by the artificial conditions prevailing. The three salient points are: (1) the restriction scheme, which is not unanimously accepted; (2) the Buffer Pool, which is very largely condemned; (3) the private pool and the mistrust which is created by reason of its origin and its relationships. The sooner it is realised by the people responsible for the present situation that the strangulation of the tin market can only result in harm, the better it will be for all parties concerned."

Day-to-day fluctuations :—

Cash.—Thursday, £224 15s. to £225; Friday, £225 5s. to £225 10s.; Monday, £225 to £225 5s.; Tuesday, £226 to £226 10s.; Wednesday £226 15s. to £227.

Three Months.—Thursday, £219 2s. 6d. to £219 7s. 6d.; Friday, £219 5s. to £219 10s.; Monday, £218 15s. to £219; Tuesday, £219 15s. to £220; Wednesday, £219 5s. to £219 10s.

Spelter.—The recent rise in zinc prices is understood to be connected with hopes of a revision of the system of import duties on both this metal and on lead. At the same time, spelter has been in good industrial demand, both in this country and on the Continent.

Official quotations were as follows :—

Ordinary.—Thursday, £14 2s. 6d.; Friday, £14 5s.; Monday, £14 12s. 6d.; Tuesday, £14 11s. 3d.; Wednesday, £14 15s.

Lead.—Messrs. Brandeis, Goldschmidt & Company report that: "Lead has again been a good market. Satisfactory business has been done with the Continent, where the demand has been better than for some time. It would appear that other countries are now beginning to share in the improvement which has been so marked in the case of lead-consuming industries in this country."

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £13 6s. 3d.; Friday, £13 7s. 6d.; Monday, £13 15s.; Tuesday, £13 16s. 3d.; Wednesday, £14.

Sheffield I.B.F. Conference

SECOND LIST OF SUBSCRIBERS TO THE GUARANTEE FUND

	£	s.	d.
Staveley Coal & Iron Co., Ltd. ...	30	0	0
Edgar Allen & Co., Ltd	30	0	0
United Steel Companies, Ltd. ...	30	0	0
Sheepbridge Coal & Iron Co., Ltd.	25	0	0
Sheepbridge Stokes Centrifugal Castings Co., Ltd. ...	25	0	0
William Jessop & Sons, Ltd. ...	20	0	0
Saml. Osborn & Co., Ltd. ...	20	0	0
Robt. Hyde & Son, Ltd.	20	0	0
Parkgate Iron & Steel Co., Ltd.	15	0	0
Fordath Engineering Co., Ltd. ...	10	10	0
Renishaw Iron Co., Ltd.	10	0	0
Jackman & Co., Ltd.	10	0	0
British Pigirons, Ltd. (subscription in full)	5	0	0
Wm. Jackson & Co., Ltd. ...	5	0	0
Sheffield Coal Co., Ltd.	5	0	0
Arthur Lee & Sons, Ltd.	5	0	0
Tinsley Park Colliery Co., Ltd. ...	5	0	0
Jas. Keith & Blackman Co., Ltd.	5	0	0
A. E. Upton, Esq.	3	0	0
Sheffield Testing Works, Ltd. ...	1	0	0
Total ...	279	10	0

"Randupson" Cement Moulding

Messrs. J. Hinckley & Son, 11, East Parade Chambers, Sheffield, have been appointed sole concessionaires for Great Britain for the Randupson process of cement moulding controlled by the Société d'Electro-Métallurgie et des Aciéries Electriques d'Ugine. At the moment the firm is busily introducing this practice to a limited number of the larger foundries in this country. The process is equally suitable for steel (including manganese steel), non-ferrous and grey-iron founders and, with proper application, will show definite savings of anything up to 30 per cent. of costs against the normal practice. Cement moulding means an entire elimination of moulding boxes and the usual types of moulding sand, the materials required being good, clean silica sand and a rapid-hardening cement.

XUM

the basis of good cupola ganister....

Cupola operators, who take pride in the repair of their furnace linings, are justified in demanding a true ganister, made of hard Sheffield ganister rock and specially selected plastic fireclay, blended by craftsmen who understand their work.

SHEFFIELD GANISTER ROCK

Scene in a ganister mine

GENERAL REFRACTORIES LIMITED

Telephones: Sheffield 22311 (5 lines), London 7361 Temple Bar

Head Office: Genefax House, Sheffield

London Office: Russell House, Adelphi, W.C.2

Telegrams: Genefax, Sheffield, Genefax, Rand, London

RAW MATERIALS—PRICE LIST

(Wednesday, May 15, 1935)

COPPER

	£	s.	d.
Standard cash	33	8	9
Three months	33	17	6
Electrolytic	37	0	0
Tough	35	5	0
Best selected	35	15	0
Sheets	62	0	0
India	47	5	0
Wire bars	37	5	0
Ingot bars	37	5	0
H.C. wire rods	40	0	0
Off. av. cash, April	31	5	4⅞
Do., 3 mths., April	31	13	9
Do., Sttlmnt., April	31	5	3
Do., Electro, April	35	1	10½
Do., B.S., April	34	13	0⅝
Do., wire bars, April	35	8	6
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS

Solid drawn tubes	9½d
Brazed tubes	11¼d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7¾d.
Wire	7½d.
Rolled metal	7¾d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	226	15	0
Three months	219	5	0
English	227	5	0
Bars	229	0	0
Straits	235	5	0
Australian (nom.)		—	
Eastern	229	5	0
Banca	234	15	0
Off. av. cash, April	223	13	8¼
Do., 3 mths., April	219	18	0¾
Do., Sttlmt., April	223	13	9

SPELTER

	£	s.	d.
Ordinary	14	15	0
Remelted	14	7	6
Hard	11	5	0
Electro 99.9	17	6	3
English	15	16	3
India	13	0	0
Zinc dust	17	10	0
Zinc ashes	3	5	0
Off. aver., April	13	0	2¼
Aver. spot, April	12	17	9¾

LEAD

	£	s.	d.
Soft foreign ppt.	14	0	0
Empire (nom.)	15	2	6
English	16	0	0
Off. average, April	12	6	10⅞
Average spot, April	12	4	7½

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do., V.M. ex-whse.	23	17	6
Rods	28	0	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	76	0	0	to	77	0	0
Chinese, ex-whse., (nom.)					64	0	0
Crude						—	

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	7	6	to	11	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon—			
25%	8	17	6
45/50%	12	15	0
75%	17	17	6
Ferro-vanadium—			
35/50	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	4/6 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£15	15	0
Ferro-tungsten—			
80/85%	3/- lb.		
Tungsten metal powder—			
98/99%	3/3 lb.		
Ferro-chrome—			
2/4% car.	31	10	0
4/6% car.	21	15	0
6/8% car.	21	10	0
8/10% car.	21	10	0
Ferro-chrome—			
Max. 2% car.	34	0	0
Max. 1% car.	36	5	0
Max. 0.70% car.	37	5	0
70% carbon-free	9¾d. lb.		
Nickel—99.5/100%	£200 to £205		
"F" nickel shot	£184	0	0
Ferro-cobalt, 98/99%	5/- to 5/6 lb.		
Metallic chromium—			
96/98%	2/5 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0	to £11	5 0
76/80% packed	£11 15 0	to £12	5 0
76/80% export (nom.)	£9	15	0
Metallic manganese—			
94/96% carbon-free	1/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d
Finished bars, 18% tungsten	2s. 9d

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	15	0	to 2	16	0	
Bundled shrngs.					2	7	6
Mixed iron and steel	2	10	0	to 2	12	0	
Heavy cast iron	2	11	0	to 2	13	6	
Good machinery	2	12	6	to 2	15	0	
Cleveland—							
Heavy steel				2	12	6	
Steel turnings				1	15	0	
Cast-iron borings				1	5	0	
Heavy cast iron	2	12	6	to 2	13	0	
Heavy machinery				2	15	0	
Midlands—							
Light cast-iron scrap				2	7	6	
Heavy wrought iron				2	17	6	
Steel turnings, f.o.r.				1	14	0	
Scotland—							
Heavy steel				2	10	0	
Ordinary cast iron				2	12	6	
Engineers' turnings				1	19	6	
Cast-iron borings	1	17	6	to 1	19	0	
Wr'ght-iron piling	2	16	6	to 2	18	6	
Heavy machinery				2	16	6	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	18	0	0
Lead (less usual draft)	12	0	0
Tea lead	8	10	0
Zinc	9	0	0
New aluminium cuttings	66	0	0
Braziery copper	23	0	0
Gunmetal	25	0	0
Hollow pewter	155	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-

Scotland—

Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-

Sheffield (d/d district)—

Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.		£	s.	d.
Iron—							
Bars (cr.)	9	12	6	to 9	15	0	
Nut and bolt iron	7	10	0	to 8	0	0	
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.				12	0	0	
Gas strip				10 10 0 and up.			
Bolts and nuts, ¾ in. × 4 in.				14	2	6	and up.
Steel—							
Plates, ship, etc.	8	15	0	to 8	17	6	
Boiler plts.	9	5	0	to 9	7	6	
Chequer plts.				10	7	6	
Angles				8	7	6	
Tees				9	7	6	
Joists				8	15	0	
Rounds and squares, 3 in. to 5½ in.				9	7	6	
Rounds under 3 in. to ⅝ in. (Untested)				8	12	0	
Flats—8 in. wide and over				8	12	6	
,, under 8 in. and over 5 in.				8	17	6	
Rails, heavy	8	5	0	to 8	10	0	
Fishplates	12	5	0	to 12	10	0	
Hoops (Staffs)				9	7	0	
Black sheets, 24g. (4-t. lots)				10	10	0	
Galv. cor. shts. (,,)				13	0	0	
Galv. flat shts. (,,)				13	10	0	
Galv. fencing wire, 8g. plain				14	10	0	
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to 7	2	6	
Sheet bars	5	2	6	to 5	10	0	
Tin bars	5	2	6	to 5	7	6	

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9¾d.
Sheet to 10 w.g.	10¼d.
Wire	12d.
Rods	10¾d.
Tubes	13½d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1¼ to 1/7¼
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	19/- to 22/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/2 to 19/2
,,	28×20	,,	36/4 to 38/4
,,	20×10	,,	26/- to 26/3
,,	18¾×14	,,	18/6 to 18/9
C.W.	20×14	,,	15/3 to 16/3
,,	28×20	,,	32/9 to 33/3
,,	20×10	,,	22/9 to 23/9
,,	18¾×14	,,	15/9 to 16/9

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	6	0	0	to	7	0	0
Bars-hammered, basis	16	0	0	to	16	10	0
Bars and nail-rods, rolled, basis	15	15	0	to	16	0	0
Blooms	10	0	0	to	12	0	0
Keg steel	30	0	0	to	31	0	0
Faggot steel	18	0	0	to	23	0	0
Bars and rods dead soft, st'l	10	0	0	to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
May	9 ..	32	17	6	inc.	5/-
,,	10 ..	33	3	9	,,	6/3
,,	13 ..	33	8	9	,,	5/-
,,	14 ..	33	15	0	,,	6/3
,,	15 ..	33	8	9	dec.	6/3

Electrolytic Copper

		£	s.	d.		
May	9 ..	36	10	0	inc.	10/-
,,	10 ..	36	10	0	No	change
,,	13 ..	36	10	0	,,	,,
,,	14 ..	37	0	0	inc.	10/-
,,	15 ..	37	0	0	No	change

Standard Tin (cash)

		£	s.	d.		
May	9 ..	224	15	0	inc.	15/-
,,	10 ..	225	5	0	,,	10/-
,,	13 ..	225	0	0	dec.	5/-
,,	14 ..	226	0	0	inc.	20/-
,,	15 ..	226	15	0	,,	15/-

Tin (English ingots)

		£	s.	d.		
May	9 ..	225	10	0	inc.	20/-
,,	10 ..	226	0	0	,,	10/-
,,	13 ..	225	10	0	dec.	10/-
,,	14 ..	226	10	0	inc.	20/-
,,	15 ..	227	5	0	,,	15/-

Spelter (ordinary)

		£	s.	d.		
May	9 ..	14	2	6	inc.	2/6
,,	10 ..	14	5	0	,,	2/6
,,	13 ..	14	12	6	,,	7/6
,,	14 ..	14	11	3	dec.	1/3
,,	15 ..	14	15	0	inc.	3/9

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
May	9 ..	16	15	0	inc.	2/6
,,	10 ..	16	16	3	,,	1/3
,,	13 ..	17	3	9	,,	7/6
,,	14 ..	17	2	6	dec.	1/3
,,	15 ..	17	6	3	inc.	3/9

Zinc Sheets (English)

		£	s.	d.		
May	9 ..	23	10	0	No	change
,,	10 ..	23	10	0	,,	,,
,,	13 ..	24	0	0	inc.	10/-
,,	14 ..	24	0	0	No	change
,,	15 ..	24	0	0	,,	,,

Lead (English)

		£	s.	d.		
May	9 ..	15	5	0	inc.	5/-
,,	10 ..	15	5	0	No	change
,,	13 ..	15	15	0	inc.	10/-
,,	14 ..	15	15	0	No	change
,,	15 ..	16	0	0	inc.	5/-

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	87 0	87 0	87 3	87 2½	87 6	89 6	89 6	89 10½	86 11
1930	91 6	91 6	91 6	90 0	89 7½	88 0	87 7½	86 6	86 6	86 6	86 6	86 6	88 6½
1931	86 6	84 6	84 6	84 6	84 6	82 6	82 6	81 6	81 6	83 6	83 6	83 6	83 7
1932	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1933	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1934	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	85 6
1935	83 6	83 6	83 6	83 6	—	—	—	—	—	—	—	—	—

* No prices available.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOREMAN or Assistant Foreman. Position required. Experienced general engineering castings up to 30 tons. British and American experience. Technically trained.—Box 250, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

IRONFOUNDRY Foreman working in Lancashire town seeks position with progressive firm; 36 years' experience in modern foundry practice.—Box 248, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN. Young man wanted, capable of taking charge of light-casting foundry in New Zealand making castings for enamelling. Sound practical knowledge of moulding essential, also cupola practice. Good prospects for right man. Apply, stating age and full details of experience, to Box 254, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

IRONFOUNDRY Foreman seeks re-engagement. Thoroughly experienced in light castings on most up-to-date plant, including mechanisation. Sound technical training; would take full charge or any situation offering prospects. (259)

PRACTICAL Foundryman with sound experience of mixing of aluminium and special alloys desires position. (260)

AGENCY

IRONFOUNDERS desirous of adding Rainwater Castings. Prospects excellent. Communicate with Box 246, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1934 edition. Price 52s., morocco. Order *YOUR* copy *NOW*.—Industrial Newspapers, Limited, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

TILGHMAN SAND BLAST ROOM for sale, 12 ft. by 9 ft., standard-type plant, practically new, owing to centralisation. This plant can be seen erected and will be sold reasonably owing to the closing of a large works, in London.—Box 252, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY—*Continued*

MORGAN TILTING FURNACES for sale: sizes 400, 600 and 800 lbs. capacity; several in stock, oil-fired, also coke-fired. Please state requirements. Cheap prices; immediate delivery; relined ready for use.—Alex. Hammond, 14, Australia Road, Slough.

CUPOLA BLOWING FANS.

6-in. Outlet, Keith Blackman.
8-in. Outlet, Keith Blackman.
10-in. Outlet, Keith Blackman.
New and Unused. Six Months' Warranty.
Complete with A.C. Motors and Oil-immersed Starters. Bargain Prices.
A. Hammond, 14, Australia Road, Slough.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. Davies & Son, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

New HACK-SAWING MACHINES, blade 14" long: cap. 6" x 6"; 14" dia. single-pulley drive.

25" motor-driven VENTILATING FANS (Davidson); series motor (Scott), 100 volts; starter.

5 LANCS. BOILERS, 30' x 8', 100 lbs. w.p.

Very good land-type BABCOCK WATER-TUBE BOILER, 3,580 sq. ft. heating surface, 170 lbs. w.p.

Write for "Albion" Catalogue.

Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD

MISCELLANEOUS

FERRO-CHROME specially crushed for ladle additions. Samples and prices on application to Box 240, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—Furmston & Lawlor, Letchworth.

PROCESS of Core Oil and Compound manufacturing, suitable for large users of this product available. Recipes, raw materials, together with complete plant, combined with 20 years' experience, at a small cost. Write for particulars by only those who are genuinely interested to Box 242, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS—*Continued*

'Phone: 287 SLOUGH

MOULDING MACHINES

406 OSBORN jolt rollover.
No. 4 BRITANNIA rollover jolter.
18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.

SANDBLAST PLANTS

8'×8'×8' Tilghman room plant with 300 cu. ft. Tilghman compressor dry air filter and all equipment, practically new plant throughout.

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories. FINE PLANT.

T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".

T.B. 1 Tilghman sandblast barrel 30"×20".

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

GANISTER

Purchase your supplies from actual Producers with over 50 years' reputation

Scientifically treated, specially ground Ganister for Cupolas, Iron & Steel Works, &c.

SPECIAL LADLE GANISTER

TRIAL BAGS FREE
Quotations on application

The ASTBURY SILICA CO.
CONGLETON, Cheshire
Est. 50 Years

SELECT YOUR MACHINE FROM THE LARGEST STOCK OF HIGH CLASS SECONDHAND MOULDING MACHINES IN THE WORLD

Practical Advice Free

THE COLEMAN FOUNDRY EQUIPMENT CO., LTD., 156, STRAND, LONDON, W.C.2.